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CONTENTS

NONFERROUS METALS, ALLOYS, BRAZES, SOLDERS

NONMETALLIC MATERIALS

PREPARATIONS

TREATMENTS

WELDING, BRAZING, SOLDERING

MISCELLANEOUS

Apparatus for Studying Friction of Solid Bodies at Low Temperatures

917D0037E Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 895-902

[Article by S. S. Karapetyan, All-Union Scientific Research Institute of Optical-Physical Measurements, Moscow]

UDC 539.621

[Abstract] The TNT series of low-temperature friction-measuremnt equipment allows the tensoresistor to be located inside the operating chamber in an area of stable temperature or to be calibrated during measurement at any temperature. This reduces the error in measurement of friction parameters to 1%. The series of measurement equipment includes devices of two types: the first type can be used to study the friction of solid bodies from 5 to 600 K with constant monitoring of the composition and pressure of the gas medium between 10^{-8} and 10^{3} Pa with simultaneous exposure of the friction surfaces to radiation; the second group of instruments is designed to study friction in a medium of liquefied gases, including liquid helium, at 11.5 to 300 K. Cross-sectional diagrams of both types of devices are presented. Figures 4; References 11: 7 Russian, 4 Western.

Influence of Polyaminoimide Structure on Friction Properties of Antifriction Polymer Coatings

917D0036C Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 675-680

[Article by I. A. Gribova, L. S. Fedorova, G. Ye. Morozova, V. V. Stepochkina, L. I. Komarova, M. I. Sentyurikhina, V. M. Yarosh, V. V. Anokhin, A. P. Krasnov, Institute of Heteroorganic Compounds imeni A. N. Nesmeyanov, Moscow]

UDC 621.891.893

[Abstract] A study is presented of the process of structuring of an oligomer binder in a thin layer on a metallic substrate and its influence on friction properties. Coatings 20 μm thick were obtained by atomization of a suspension onto a metal substrate with subsequent heat treatment at 423, 473 and 523 K. Friction properties were studied with a load of 0.1 MPa at 0.3 m/s. It was found that the migration copolymerization reaction begins at 373 K during heat treatment. The structure of the polymer influences its thermal stability: a specimen with linear structure heat treated at 423 K has an area of highly elastic deformation at 453-613 K. Partially cross-linked and cross-linker polymers manifest deformation changes only at 653-663 K as the polymer starts to decompose. The best wear resistance is manifested by coatings heat treated at 473 K with partially cross-linked structure in a polymer containing succinimide and imide rings. Increasing the heat-treatment temperature to 523 K increases the content of the cross-linked structure and causes oxidation of MoS_2, resulting in unstable friction characteristics and an increase in the coefficient of friction. Figures 2; References 8: Russian.

Influence of Magnetic Field on Hydrodynamics of Magnetic-Fluid Lubricant Layer Between Convex Profiles

917D0036D Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 689-696

[Article by A. N. Vislovich, V. V. Dudarev, V. F. Medvedev, Belorussian Institute of Technology imeni S. M. Kirov, Minsk]

UDC 621.891.2:621.822

[Abstract] A simple analytic model is developed for a lubricant layer, yielding a clear idea of the very complex mechanism of interaction of magnetic and hydrodynamic forces in the lubricant layer considering the nonlinear nature of the magnetization curve. The equations derived indicate that the primary characteristics of the lubricant layer may change either smoothly or suddenly with a change in the parameters determining the friction conditions. Sudden changes in the length of the lubricant layer can be observed experimentally with a change in rotating speed of the cylinders in a friction machine for a fixed layer thickness or at fixed speeds as the load on the cylinders is changed. Figures 5; References 20: 17 Russian, 3 Western.

Friction Characteristics of TiN Coatings Obtained by Physical Precipitation in Vacuum

917D0036E Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 704-708

[Article by M. Babich, B. Yermich, University imeni Svyatozar Markovich, Kraguyevats, Yugoslavia]

UDC 621.787

[Abstract] Results are presented from friction testing of three types of coatings: I—a TiN coating obtained by ionic sputtering; II—a TiN and III—a TiAlN coating obtained by plasma-arc sputtering. The friction characteristics of the modified contact layers were studied on a universal friction machine in pin-disk mode over a broad range of contact pressures and slipping speeds. The contact between the pin and the disk was maintained in continuous slip mode. The coatings tested were found to have different friction properties, the differences depending on test conditions. Under low-load conditions, the lowest coefficient of friction was that of the TiAlN coating, whereas under higher loads the TiN coating had the lowest coefficient of friction. The advantage of this coating increases with increasing slipping speed. Figures 2; References 5: Western.

Influence of Laser Carbon Alloying on Wear Resistance of Titanium Alloys

917D0036F Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 717-722

[Article by O. M. Ivasishin, P. Ye. Markovskiy, Ye. A. Markovskiy, Institute of Casting Problems; Institute of Metal Physics, Ukrainian Academy of Sciences, Kiev]

UDC 621.891

[Abstract] A study is presented of the influence of laser surface carbon alloying on the friction properties of titanium alloys considering possible changes in their strength and plasticity characteristics as functions of the thickness of the carbide-hardened layer. Studies were performed on VT6 and VT23 alloy with initial annealed $\alpha + \beta$ structure. Specimens for mechanical testing were cut from sheet material 1.0-1.8 mm thick, while wear-test specimens were cut from a bar 16 mm in diameter. Laser melting and carburization were performed on a laser installation with a pulse power of 60 J, the melting depth varying between 20 and 800 μm as the energy density of the pulse was changed by focusing the beam. The carburizer used was colloidal graphite applied to the cleaned and degreased surface of the alloy. Repeated melting was performed to produce layers over 150 μm thick. Laser melting without addition of carbon decreases wear slightly, whereas the addition of carbon increases wear resistance greatly, particularly with increasing loads. The presence of the surface layer has a significant influence on the mechanical properties of the alloys, decreasing strength and yield point, as well as relative elongation. For titanium alloys operating in friction couples with loads of up to 20 MPa and lubrication, carbide coatings not over 20-25 μm thick are preferable, significantly increasing wear resistance without catastrophically reducing other mechanical characteristics. Figures 4; References 8: 5 Russian, 3 Western.

Friction Interaction of Ceramic Based on Nonmetallic Refractory Compounds With Steel

917D0036B Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 660-667

[Article by Yu. G. Gogotsi, A. M. Kovalchenko, I. A. Kossko, V. P. Yaroshenko, Institute of Materials Science Problems, Ukrainian Academy of Sciences, Kiev]

UDC 01:001.18:621.762.5:621.893:666.3/7:621.822.022.3

[Abstract] Tests were performed on hot-pressed ceramic materials based on nonmetallic refractory compounds Si_3N_4, B_4C, SiC and AlN with a counterbody of type 45 steel with HRC 42-45. Friction occurred without lubrication in air at 4 MPa and 1-6 m/s on a type M22M friction machine. Ceramic specimens with both rough and polished surfaces were tested. The tests indicated that slight interaction of the ceramic with the steel except for B_4C. The major compound formed on the surface of the steel was iron oxide. The lowest coefficient of friction was found in Si_3N_4 and AlN ceramics, related to the lack of any reaction of these ceramics with the iron, causing a lower value of the adhesion component of the coefficient of friction. Processes which reduce surface roughness decrease the total wear of the friction coupled. Figures 5; References 14: 11 Russian, 3 Western.

Influence of Synthetic Lubricant Fluids on Chemical and Friction Characteristics of Contacting Surfaces

917D0036A Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 643-650

[Article by L. S. Rapoport, N. S. Sazonova, V. I. Agafiy, Institute of Applied Physics, Moldavian Academy of Sciences, Kishinev, All-Union Scientific Research Institute of Oil Refining, Moscow]

UDC 621.891

[Abstract] A study is presented of the friction and chemical characteristics of certain synthetic fluids used as dispersion media and their influence on surface states. The media selected were the most promising synthetic lubricants used in the manufacture of plastic lubricants: M9S, PET, DEBYaK and a mixture of M9S and DEBYaK. The best antifriction properties for two types of steel were exhibited by M9S, a result of the good shielding effect, protecting the surface from plowing. The thermal oxidative stability of the materials decreased over time. The material M9S plus DEBYaK was found to have the greatest thermal oxidative stability. This combination had the best overall antifriction, antiwear and surface-protection properties. Figures 2; References 7: Russian.

UDC 539.375:621.762:678.067

Influence of Structured Filler on Friction Characteristics of Epoxy Coatings

917D0037D Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 882-888

[Article by M. M. Bliznets, Ye. I. Kuzmenkova, Institute of Mechanics of Metal-Polymer Systems, Belorussian Academy of Sciences, Gomel; Gomel Cooperative Institute]

[Abstract] A study is made of the influence of magnesium oxychloride, dry lubricants and carbon fibers on the wear rate, adhesion and physical-mechanical properties of epoxy coatings. Experiments were performed on ED-20 epoxy-diane resin and PEPA hardener. Minima are found in the wear rate curve at 10 and 22 mass parts magnesium oxychloride. Hardness is greatest at approximately these same two points. This indicates that the magnesium oxychloride improves both physical-mechanical properties and resistance to friction-contact fatigue of the structural grid of the binder. Impact toughness and adhesion of the composite material, as well as internal stresses in coatings made of it are greatest

at 5-7 mass parts. Heat-treatment temperature also influences the mechanical and friction properties, the best properties achieved at 160-180°C. Figures 2; References 15: 12 Russian, 3 Western.

Search for Optimal Antifriction Carbon Fiber-Filled Molding Material Composition With Simultaneous Variation of Quantitative and Qualitative Factors

917D0037F Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 903-906

[Article by G. A. Sirenko, V. P. Sviderskiy, N. L. Namashkalov, O. S. Drobot, Khmelnitsa Institute of Technology]

UDC 621.891:621.893

[Abstract] The purpose of this work was to optimize the composition of a carbon fiber-filled molding material (Karbovoloknit) based on ED-20 epoxy-diane and RFN-60 phenol-formaldehyde resins filled with carbon fibers and lubricant based on an epoxidized benzylphenol-amine adduct. Studies were performed on high-modulus graphitized fibers based on LU-2 polyacrylonitrile heat-treated at 2400°C and low-modulus carbon fibers based on hydrate cellulose: UTM-8 heat-treated at 850°C, TGN-2m—2400°C and Ural-T15—1500°C. Antifriction studies were performed in compressor oil type Ks-19 and in KS-19 containing 5 mass percent copper-plated colloidal graphite. Regression models are obtained adequately describing the process of wear of the antifriction material, indicating that the wear resistance of the material is primarily determined by the state of the matrix. The ratio of the resins in the optimal composition is determined by increasing the content of the stronger phenol-formaldehyde resin to 62.1 mass parts. With the copper-treated graphite present the content of the epoxy-diane resin should be increased to 49.6 mass parts due to the better adhesion capability of the epoxy-diane resin, supporting more complete transfer of copper ions to the contacting surface of the antifriction material. Ural-T15 fiber and tetraethylene tetraamine are found to be the best components. Figure 1; References 4: Russian.

Physical-Mechanical Properties of Polymer Composite Materials Based on Polytetrafluoroethylene and Coke

Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 878-881

917D0037C [Article by V. M. Baranovskiy, A. a. Khomik, T. V. Lyashko, S. I. Bondarenko, A. K. Pugachev, Yu. V. Zelenev, Kiev State Pedagagic Institute imeni A. M. Gorkiy]

UDC 678.642:636.1

[Abstract] The heat conductivity of polytetrafluoroethylene (PTFE) can be significantly increased while its coefficient of linear expansion is decreased by the introduction of a filler with good heat conductivity and low coefficient of layer expansion, such as coke. Studies were performed to determine the temperature and concentration variations of certain physical-mechanical, friction and other characteristics of unfilled PTFE and of polymer composites based on it with type KL-1 coke filler. Introduction of up to 20 mass percent coke is found to increase the crystallinity of the polymer, slightly increasing the coefficient and decreasing the wear rate. Further increases in coke content result in a small increase in coefficient of friction and stabilization of the wear rate. The composite materials produced have superior physical-mechanical, friction and heat-physical characteristics. Figures 2; References 8: Russian.

Friction Properties of AFTAL Antifriction Coating as Movement Starts

917D0037B Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 858-862

[Article by Yu. N. Oddakas, Chemical Industry Automation Design Bureau, Voronezh]

UDC 621.893

[Abstract] A study is made of the friction properties of the composite antifriction coating Aftal based on polytetrafluoroethylene fabric in a ball joint. Studies were performed with an Aftal layer 1 mm thick loaded in uniaxial compression as movement was started in a friction machine. The studies showed that the specifics load an initial temperature had the greatest influence on the coefficient of friction and its change as movement started in each cycle of operation of the friction machine. Figures 5; References 3: 2 Russian, 1 Western.

Increasing Wear Resistance of Detonation Coatings by Optimizing Coating Conditions

917D00337SA Minsk TRENIYE I IZNOS in Russian Jul-Aug 90 pp 844-848

[Article by V. V. Shcheptov, A. M. Volkhov, Kiev]

UDC 621.891:621.762

[Abstract] Optimization of the coating process on the basis of the wear-rate criterion allows the selection of a combination of process factors to minimize the wear rate. A series of experiments was conducted to determine the additive influence of process and use factors on wear rate. Optimal coating conditions were determined by multifactor experimental planning and mathematical processing of statistical data. The use of extreme rotatable D-optimal plans generated by the Box-Wilson method with 99.25% efficiency, including 64 experiments, yielded results which when mathematically processed generated a regression equation which is presented as a Chebyshev polynomial. Statistical testing of the expression produced verified the significance of its coefficients and the adequacy of the model, which yielded reproducible results. Figures 4; References 4: Russian.

Regimes in the Pulsed Electric Deposition of Silicate Enamels

917D0056F Moscow ZASHCHITA METALLOV in Russian 05, Sep-Oct 90 pp 864-865

[Article by V.Ye. Myasoyedov, Ye.B. Kharitonov and Ye.N. Kanin, Ivanovsk Chemical Technological Institute]

UDC 666.293.621.374

[Abstract] An experimental determination is made of the kinetic electric potential of enamel dross as a function of solid phase concentration, addition of sulfanol and DS-10 synthanol surfactants, and frequency of the current used in pulsed electric deposition of silicate enamel coatings. The optimum solid phase content was found to be between 20 and 30 percent for a frequency of about 25 Hz. References 6 Russian; figures 2.

Improving the Protective Properties of Polymer Coatings Using Inhibiting Surfactants

917D0056E Moscow ZASHCHITA METALLOV in Russian, Sep-Oct 90 pp 854-857

[Article by L.L. Mitrokhina, O.I. Chernikov and V.N. Goncharuk, Petrochemisty Department of the UkSSR Academy of Sciences Physical and Organic Chemisty and Coal Chemisty Institute]

UDC 621.792.6:620.193.4

[Abstract] The authors investigated the protective effect (as measured by the polarizational resistance) and adhesion (as measured by resistance to delamination) of polymer coatings on metal surfaces and Polyken primer that have been treated with various concentrations of Ukrinol sulfonate inhibiting surfactant. Optimum concentrations of adsorbed surfactant in the metal and primer are found. References 6: 5 Russian, 1 Western; figures 2; tables 1.

Interphase Interactions Between a Metal and Siloxane Anticorrosion Coating

917D0056D Moscow ZASHCHITA METALLOV in Russian, Sep-Oct 90 pp 759-765

[Article by M.A. Petrunin, A.P. Nazarov, R.M. Zaytsev and Yu.N. Mikhaylovskiy, Pipeline Construction SRI (A-U)]

UDC 620.198

[Abstract] A study is made of the effect of a siloxane elastomer on the surface of St3 steel on the adhesion and water-resistance of siloxane coatings. St3 steel samples were polished, cleaned, and submerged in a 5 to 10 percent solution of silane in toluol for 10 min, then the toluol was evaporated off, leaving the elastomer. The silane adsorption by the St3 was measured using reflective IR spectroscopy and the effect of the silane on the resistance to the anodic steel solution determined. It was found that the formation of adhesion centers on the carbon steel surface improves the adhesion of siloxane primer, but adhesion of the coating now depends on the chemical characteristics of the triethoxysilane organic radicals at the primer/coating interface. This treatment of the samples does significantly increase the water-resistance of anticorrosion coatings. References 12: 4 Russian, 8 Western; figures 3; tables 2.

Electrochemical and Corrosion Investigation of Binary Titanium-Niobium Alloys in Sulfuric Acid

917D0056C Moscow ZASHCHITA METALLOV in Russian 05, Sep-Oct 90 pp 753-758

[Article by A.I. Shcherbakov, V.N. Dorofeyeva and N.D. Tomashov, USSR Academy of Sciences Physical Chemistry Institute]

UDC 620.193.41

[Abstract] Anode and cathode characteristic curves were determined, using established values of the corrosion potential, for binary alloys of Ti and Nb (0, 1, 3, 5 and 11 percent by weight Nb) in hot sulfuric acid. A pure titanium sheet and niobium foil were used as electrodes, as per the Evans corrosion pair model, and short-circuited through a resistance box. It is found that niobium retards the anodic dissolving of the binary alloy because it is preferentially dissolved in the initial stages of corrosion, and so higher niobium concentrations facilitates the cathode process. However, the increased anode process efficiency for niobium concentrations less than 11 percent is not enough for passivation and significant improvement of the anti-corrosion of the alloy as a whole. In fact, niobium can even promote selective corrosion of the titanium α-phase. The authors therefore recommend additional doping with a more effective cathode component such as nickel. References 14: 10 Russian, 4 Western; figures 3; tables 1.

Sulfonate-Based Corrosion Inhibitors and Protective Agents

917D0056A Moscow ZASHCHITA METALLOV in Russian 05, Sep-Oct 90 pp 707-722

[Article by Yu.N. Shekhter, I.Yu. Rebrov, N.V. Kardash, O.S. Stepuro, M.V. Pospelov and A.Yu. Petrov, Petroleum Refining SRI (A-U)]

UDC 620.197.3

[Abstract] Doping of a metal surface under static and dynamic conditions using oil-soluble surfactants containing the dopant and other elements facilitating the formation of a thick chemisorption film is shown to improve the performance of corrosion inhibitors against hydrogen, corrosion and mechanical wear. The surfactants contained sulfonates of Ca, Ni, Co, Mo, Mg and Ba in varying concentrations, as well as P, B, Mo, Zn, Cu, Cr, Ti and Ni. Tests conducted on light trucks and buses with gas and diesel engines using these multi-element

organic surfactant compositions showed that the service life of transmissions increased from 3-12 months to 3-10 years, hydrogen and corrosion/mechanical wear was reduced by 30-50 percent, and and fuel savings of 1-5 percent (by weight) were realized. Literature data on the properties of oil-soluble compounds containing doping element cations is tabulated. References 88: 87 Russian, 1 Western; tables 5.

Mechanism of the Protective Action of Surface Carbide Layers on Titanium

917D0056B Moscow ZASHCHITA METALLOV in Russian 05, Sep-Oct 90 pp 740-744

[Article by T.V. Chukalovskaya, N.P. Chebotareva and N.D. Tomashov, USSR Academy of Sciences Physical Chemistry Institute]

UDC 620.198

[Abstract] The authors investigated the mechanism responsible for anticorrosion properties of a surface carbide layer deposited on titanium in a 6.7 kPa methane atmosphere at 1000 °C in sulfuric acid solutions. Comparisons are made of microscopic cross-sections of surface carbide layers on titanium before and after corrosion (following activation of the sample) are compared. The anode characteristics and electrochemical characteristic curve as layer after layer of the carbide was removed down to bare titanium is determined. The behavior of the galvanic Ti-TiC pair and the corrosion diagram for this combination are studied. It is found that the mechanism varies depending on the aggressiveness of the corroding agent and conditions: for high temperatures and highly acidic compounds, where titanium passivation is difficult to acheive, a screening mechanism predominates; and for less aggressive conditions, an electrochemical mechanism is found to predominate. References 3 Russian; figures 4; tables 1.

Influence of Copper Concentration on Magnetic Properties and Structure of Alloys

917D0052A Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Aug 90 pp 23-32

[Article by A. G. Popov, V. S. Gaviko, L. M. Magat, G. V. Ivanova, Institute of Metal Physics, Urals Division, USSR Academy of Sciences]

UDC 669.859'23/20'3:537.622

[Abstract] A study is made to determine the composition of the phases and their magnetic characteristics in $Sm(Co, Fe, Cu, Zr)_z$ alloy magnets (where z is 6.8-8.5), and to compare the experimental values of H_c with the values calculated according to domain-boundary-shift models. It is found that the variation of H_c as a function of copper concentration in the 1:5 phase agrees qualitatively with that calculated in the model of attachment of boundaries by planar defects. The redistribution of alloy components among phases during aging apparently occurs in two stages, with the volumetric fraction of the 1:5 phase decreasing in the first stage with an increase in Sm and Cu content and an increase in stresses between phases. In the second stage the relaxation of these stresses occurs due to formation of narrow copper-rich areas at the phase interface. The sharp increase in H_c occurs when γ (1:5) becomes less than γ (2:17) at a certain critical copper concentration. Figure 7; References 24: 16 Russian, 8 Western.

Electronic Properties and Stability of Amorphous Phase in Beryllium-Hydrogen System

917D0052B Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Aug 90 pp 41-48

[Article by V. M. Kuzmenko, V. I. Melnikov, T. P. Chernyayeva, V. V. Bryk, Kharkov Physical-Technical Institute, Ukrainian Academy of Sciences]

UDC 669.725'788:(539.213+539.216.2):538.945

[Abstract] The purpose of this work was to obtain the thickest possible homogeneous films of a-Be by stabilizing the amorphous phase with a hydrogen impurity and to investigate their electronic properties and stability. Hydrogen was selected as the stabilizing impurity because it does not enter into direct chemical reactions with Be and is practically insoluble in it. The condensation of Be on a liquid-helium-cooled substrate at a hydrogen pressure of about 4.67×10^{-5} Pa allows reproducible production of homogeneous superconducting films of this metal containing not over about 1 at.% hydrogen. The small hydrogen impurity has practically no influence on the electronic parameters. With a film thickness of over 25 nm these parameters are independent of layer thickness and can therefore be considered parameters of a massive amorphous Be phase. The high values of T_c of this phase, over 10 K, result primarily from the higher density of states on the Fermi surface. Avalanche or explosive crystallization in a-Be (H) films does not occur, possibly due to the requirement of diffusion transfer of hydrogen atoms for the phase transition to occur. Figures 5; References 29: 15 Russian, 14 Western.

Anisotropy of Dynamic Magnetrostriction of Silicon Iron and Its Variation With Frequency

917D0052C Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Aug 90 pp 49-53

[Article by I. Ya. Eyngorn, V. F. Tiunov, V. A. Zaykova, Institute of Metal Physics, Urals Division, USSR Academy of Sciences; "Zaporozhtransformator" Production Association]

UDC 669.1'782:537.634.2

[Abstract] A study is made of the frequency variation of dynamic magnetostriction and its anisotropy in textured electrical steel. The dynamics of the domain structure were observed in crystals of Fe-3% Si unordered set: 110<001> at various frequencies in various crystallographic directions. A monotonic increase in dynamic magnetostriction with frequency is observed, almost doubling in all specimens between 15 and 400 Hz. The behavior of the domain structure is used to explain the variation in magnetostriction amplitude with angle α and frequency. The increase in magnetostriction amplitude with frequency is related to an increase in the relative volume of the specimen which is remagnetized by displacement of 90° boundaries, since the secondary domain structure depth increases with frequency while the time interval of existence of the band structure in the remagnetization cycle decreases. The reasons for this behavior of domain structure with increasing frequency are not clear. It may result from eddy-current processes occurring near the domain boundaries. Figures 3; References 10: 9 Russian, 1 Western.

Optical Properties of Fe-Pd Alloys in Amorphous and Crystalline States

917D0052D Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Aug 90 pp 54-59

[Article by V. G. Kravets, V. V. Litvintsev, L. V. Poperenko, I. A. Shaykevich, Kiev State University imeni T. G. Shevchenko, Irkutsk Pedagagic Institute]

UDC 669.15'234:541.65

[Abstract] A study is made of the change in electron structure of an invar alloy upon amorphous-crystalline state transformations. Ion-plasma sputtering was used to produce films of Fe-Pd alloy with 20-35 at.% Pd. The index of refraction and absorption index were measured at 0.25-12 μm by an ellipsometric method. The values of n and κ were used to estimate the plasma and relaxation frequencies of current carriers. The optical data are used to establish the basic features of formation of the state density spectrumnear the Fermi level. As the concentration of iron in the alloy increases to produce the invar composition, the width of the unfilled portion of the conductivity zone narrows and the electron state density

at the Fermi level increases. The area of invar concentrations also has the maximum electrical resistance and concentration of Fe atoms with magnetic moment antiparallel to the direction of magnetization. Figures 4; References 17: 11 Russian, 6 Western.

Magnetic Properties of Trinary Rare-Earth Compounds $RFe_{10}Mo_2$

917D0052F Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Aug 90 pp 59-64

[Article by A. S. Yermolenko, Ye. V. Shcherbakova, G. V. Ivanova, Ye. V. Belozerov, Institute of Metal Physics, Urals Division, USSR Academy of Sciences]

UDC 669.15'28'85/86:537.622

[Abstract] A study is presented of the magnetic properties of the series of compounds $RFe_{10}Mo_2$ where R = Y, Ce, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, Tm, Lu. The alloys, obtained by levitation or arc melting, where homogenized at 100°C for two days and their phase composition checked by x-ray studies. The lattice parameters were determined by extrapolation of values obtained by the position of several lines to $\theta = 90°$. The magnetic moment was measured in fields of up to 7.2 MA/m in powder specimens with particle size $d<28\mu$. The compounds were found to be highly anisotropic ferromagnetics with magnetic moments of up to $19\mu_B$ per molecule at 4.2 K and currie temperatures of 350-500 K, suitable for use as permanent magnets, though inferior to compounds with Ti and V, which have higher values of magnetic moment and currie point. Figures 5; References 14: 3 Russian, 11 Western.

Structure of High Coercivity Cu-Mn-Al Alloys

917D0052G Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Aug 90 pp 128-133

[Article by S. P. Beletskaya, T. V. Yerfimova, V. V. Kokorin, I. A. Osipenko, V. V. Polotnyuk, Institute of Metal Physics, Ukrainian Academy of Sciences]

UDC 669.3'71'74:620.181

[Abstract] A study is presented of the structural changes which occur upon heat treatment of Cu-Mn-Al alloys and determine the anomalies of their magnetic properties. Four alloys were produced: $Cu_{43.3}Mn_{21}Al_{35.7}$, at the boundary of two areas of the equilibrium state diagram, one of which contains the phase Cu_9Al_4 and β-Mn, while the other contains Cu_9Al_4, β-Mn and a β-bcc solid solution; $Cu_{42}Mn_{24}Al_{34}$ in the area containing the phase Cu_9Al_4 and β-Mn; $Cu_{16.5}Mn_{45.5}Al_{38}$, in the area with Cu_9Al_4, β-Mn and the β-bcc solid solution; and $Cu_{17.5}Mn_{35}Al_{47.5}$, in the area of the β-bcc solid solution. The results of structural analysis performed in parallel with investigation of the magnetic properties of the first two alloys indicate that their high-coercivity state is related to the liberation of a metastable phase with tetragonal crystalline lattice and high crystallographic anisotropy, which arises in the cast state and in the process of annealing of hardened alloys at 573-65 K. Figures 4; References 11: 3 Russian, 8 Western.

Movement of Fast Particles in Crystal Studied by Bogolyubov Kinetic Theory

917D0053A Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Sep 90 pp 19-28

[Article by Yu. A. Kashlev, N. M. Sadykov, Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences]

UDC 669-172:539.171.12/.65.001

[Abstract] A kinetic theory of the motion of fast particles in a crystal is developed based on the Bogolyubov chain of equations. The case is considered in which the incident energy is over 1 MeV, so that the classical description of particle dynamics is fully applicable. A generalized local equation is obtained for the distribution of states of one particle interacting with lattice oscillations. The basic characteristics are found of the system in the space of energies of transverse motion, including particle energy losses due to dynamic friction and the diffusion function. It is shown that both types of losses are related to the difference in the contribution to the kinetics of particles moving by channeling, quasichanneling and chaotic motion. The description of motion of fast particles based on the kinetic equation of Boltzmann and by means of a diffusion equation is compared. Figure 1; References 18: 6 Russian, 12 Western.

Transient Processes in Spin Systems With Pulsed Excitation

917D0053B Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Sep 90 pp 29-35

[Article by V. P. Chekmarev, V. G. Malyshev, Leningrad Electrical Engineering Institute of Communications imeni M. A. Bonch-Bruyevich]

UDC 539.143.43.001

[Abstract] Results are presented from calculation of the response of a certain spin system to a rectangular radiofrequency pulse. The study was performed by direct numerical integration of the solutions of the classical equations of Bloch without relaxation components. The error of the method is estimated and convergence conditions are determined. It is shown that with nonresonant excitation the response contains a monopulse echo, the properties of which are analyzed. Results of analysis of the properties of the pulse indicate that the effect of the monopulse echo is clearly nonresonant. This is indicated by the fact that increasing the amplitude of the pulse with sufficient detuning can achieve greater amplitudes than can be achieved by decreasing the amount of detuning. Figures 7; References 16: 12 Russian, 4 Western.

Kinetic Equation for Axial Channeling in Ordering Alloys

917D0053C Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Sep 90 pp 36-42

[Article by M. A. Ivanov, L. B. Kvashnina, Institute of Metal Physics, Ukrainian Academy of Sciences]

UDC 669.017.167.3:539.171.12/.6

[Abstract] A generalization is presented of the theory of channeling, to cover the case of ordering alloys, in which the scattering chain consists of atoms of different types located at the nodes of the chain. The displacement of atoms relative to the nodes of the chain considered in this work are small, in contrast to previous works. Primary attention is given to the case in which the closest approach of particles to the scattering chain is greater than the atomic shielded radius. An expression is derived for the diffusion coefficient, the sum of the contributions of scattering of incident particles on an atom and the scattering on individual electrons. It is shown that the electron coefficient coincides to the expression obtained for the case of single-component crystals. The atomic coefficient contains a component related to scattering on fluctuations in composition, which may be dominant in some cases over the contribution resulting from scattering on thermal and statis displacements of the atom. Figure 1; References 12: 5 Russian, 7 Western.

Effect of Magnetic Field on Low-Temperature Impedance of HTSC Yttrium Ceramic in Decimeter Wave Band

917D0053D Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Sep 90 pp 80-84

[Article by S. Ye. Demyanov, A. A. Drozd, V. R. Sobol, D. V. Pashik, T. A. Krivoruchko, A. R. Buyev, S. P. Zakatov, V. N. Saverin, Institute of Solid-State Physics and Semiconductors, Belorussian Academy of Sciences]

UDC (546.562+538.945):537.311.6:537:63

[Abstract] Results are presented from studies of the real portion of the surface resistance of an yttrium ceramic in an external magnetic field in the helium temperature area. Studies were done by recording the natural Q of a coaxial shorted resonator made of the material. It is found that at 4.2 K r_s changes slightly and linearly with H except in the area of low field intensities, where the variation is quadratic. The value of r_s at 4.2 K is 0.02 Ohms, while at 300 K it is 0.7 Ohms, which agrees with the assumption of ferroelectric absorption of the HF field power. Figures 4; References 11: 5 Russian, 6 Western.

Martensite Transformation in Ni-Ti Alloy Quenched From Liquid State With Near Equiatomic Composition

917D0053E Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Sep 90 pp 150-154

[Article by S. V. Mizin, A. I. Novikov, L. P. Fatkullina, Moscow Institute of Steels and Alloys]

UDC 669.24'295:536.42

[Abstract] A study is made of a titanium alloy with 50.8 at.% nickel. Specimens 20-40 μm thick and 1-2 mm wide were obtained by cooling from the liquid state on a spinning copper drum, achieving cooling rates of 10^5-10^6 K/s, with or without subsequent vacuum annealing at 973 K, one hour. When cooled rapidly to 103 K by this method, the B2→B19' and B2→R transformations start simultaneously. No basic differences are found in the behavior of the annealed specimens. The critical point of the transformations are determined. Quenching from the melt stabilizes the temperature of the martensite transformations upon thermal cycling of the alloy studied. Figures 2; References 7: Russian.

Investigation of Nonequilibrium Crystallization Processes in Alloys of Aluminum and Cu, Mn, Si, Ti and Zr

917D0060C Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian 06, Dec 90 pp 91-94

[Article by G.M. Kuznetsov, V.V. Istomin-Kastrovskiy, K.S. Puzakov and V.V. Suponeva, Moscow Steels and Alloys Institute, Department of Ferrous Metals Science]

UDC 669.017

[Abstract] The authors studied nonequilibrium crystallization in multicomponent alloys of aluminum and Cu, Mn, Si, Ti and Zr with unrestricted diffusion in the liquid state and no diffusion in the solid state. It was found that the first compound to crystallize in all alloys save Al-Su-Mn-Si is $TiAl_3$ or (Ti, Zr)Al_3. After a peritectic reaction, which usually did not proceed all the way, α-phase crystals were deposited on the surface of the primary crystals, changing the composition of the liquid and lowering its crystallization front temperature. This process continued through all the components in the alloy. X-ray analysis indicates that the titanium concentration in the center of dendritic cells is as much as 1.3 percent, although it was near zero in inter-axial regions. The bands that appear to link the manganese are found to be eutectic α- phase crystals that harden in this temperature interval. This article employed a program that simulated the nonequilibrium crystallization process, enabling an estimate of the degree of dendritic liquation, amount of deposited phase and composition of liquid and solid phases on the crystallization front at any point in time. References 7: 5 Russian, 2 Western; figures 3. COPYRIGHT: "Izv. vuzov. Tsvetnaya metallurgiya" 1990

The Development of Autogenous Melting Technology for Semi-Metallic Sulfides of Ores

917D0061A Moscow TSVETNYYE METALLY in Russian 07, Jul 90 pp 9-14

[Article by V.V. Mechev, director of Gintsvetmet and executive at the Autogenous Processes Engineering and Technical Center]

UDC 669.2/.8

[Abstract] Autogenous techniques for processing sulfides of semi-metallic ores are considered the most promising direction for progress in copper, nickel, lead and zinc metallurgy in the Soviet Union; currently 34.2 percent of the copper and 30 percent of the nickel are obtained using autogenous techniques. The present state of autogenous processing in the USSR and abroad is discussed. Specific proposals are made for improving the throughput of the KFP-1 complex. The author discusses introduction of Vanyukov smelters at large installations and some of the engineering problems encountered. Current shortcomings of this kind of autogenous processing are listed, and areas of future research to solve them are pointed out. Toward this end, two new smelting techniques are briefly discussed. References 4 Russian; figures 1; tables 2.

Introduction of Autogenous Technology—A Means of Solving Ecological Problems

917D0061B Moscow TSVETNYYE METALLY in Russian 07, Jul 90 pp 17-19

[Article by A.M Khalemskiy, Chief of the Engineering Division, Central Urals Copper Smelting Plant]

UDC 669.33

[Abstract] The author describes briefly the composition of gaseous waste put into the atmosphere by the Central Urals Copper Smelting Plant and plans for installing additional scrubbers to reduce it. Addition of a second Vanyukov smelting unit, as ordained in the 13th 5-Year Plan, should reduce gaseous waste by 30 percent, in addition to elimination of coal usage, higher throughput, and reduced personnel. Installation of new computer-controlled gas scrubbing and particulate-removing equipment designed to handle specific kinds of waste are described. References 6 Russian.

Future Improvement in Autogenous Processes Using Sulfurous Anhydride

917D0061C Moscow TSVETNYYE METALLY in Russian 07, Jul 90 pp 59-61

[Article by P.N. Alentov and V.S. Aleksandrovskaya under the rubric "In the Scientific and Technical Council of the USSR Ministry of Metallurgy"]

[Abstract] A joint conference of the USSR Ministry of Metallurgy's Scientific and Technical Council (STC) and the Autogenous Processes Engineering Center STC, with attendance of specialists from a number of scientific and engineering design institutes, the Moscow Steel and Alloys Institute, Urals Polytechnic, Balkhashmed PO and the Central Urals Copper Smelting Plant, met in the latter's offices in Revda in February 1990 to discuss introduction of autogenous nonferrous metallurgy during the 13th 5-Year Plan. Papers presented at the conference on operational experience in introducing Vanyukov smelters and computerized temperature monitoring equipment are summarized. Recommendations from the various scientific research and engineering design institutes are presented, and their suggested assignments for the next five years are laid out.

Hot Metal Method of Processing Waste From Titanium and Manganese Production

917D0061D Moscow TSVETNYYE METALLY in Russian 07, Jul 90 pp 76-78

[Article by O.V. Orlova, N.N. Stremilova, under the rubric "Manganese, Titanium, Rare Earth Metals and Semiconductors: Low-Waste Technological Processes and Reduction of Industrial Waste"]

UDC 669.295.720.054.79

[Abstract] A low-waste method of producing an activated reducing agent for titatium powder used in alloying that also conserves scarce metallic manganese is given: pure granulated titanium, spent electrolyte from manganese electrolytic cells, and some metallic manganese are loaded into a converter, melted at 700 to 750 °C for a half-hour, cooled, crushed, and used in solid form as a reducing agent. A similar method is used for processing spent titanium chlorate alloy. Optimum parameters for these processes are investigated. A study is made of the effect of polymetallic powders on the wear resistance of steel and iron castings, indicating potential savings of R10,000 per ton of polymetallic powder used.

Development of a Technique for Casting 40 x 260 mm Cross-Sectional Bars in a Thermal Packing Mold

917D0061E Moscow TSVETNYYE METALLY in Russian 07, Jul 90 pp 85-87

[Article by A.N. Kuznetsov, A.I. Zhernov, A.P. Nazarov, M.P. Borgoyakov, V.V. Sobolev and P.M. Trefilov]

UDC 621.74

[Abstract] The authors have developed a device for simultaneous casting of 16 bars 40 x 260 mm in cross-section in low crystallizers with thermal packing seals. It was found in experimental testing of the apparatus that the quality of the bars depends to a significant extent on the way the liquid metal is fed into the casting hole of a crystallizer; the final design brings in the alloy from the middle of the broadest side. The mechanical properties of bars made from AMg6 alloy in cast and pressed form are tabulated. The crystallization kinetics were studied using a computer model. References 5 Russian; figures 3; tables 2.

Phase Composition of Binder in VNZh-Type Heavy Alloys

917D0061F Moscow TSVETNYYE METALLY in Russian 07, Jul 90 pp 92-94

[Article by A.M. Zakharov, A.V. Nikolskiy, V.G. Parshikov and L.S. Vodopyanova]

UDC 669.017.14

[Abstract] New data about the phase composition of alloys in the Ni-W system suggests that the binder in heavy alloys may have a complex phase composition that is temperature dependent. The authors study the effect of adding 1:1 Fe and Co on the melting point and phase composition of W + 10 percent Ni alloy to test the idea that in addition to nickel-based solid γ-solution there may also be intermediate phases of NiW and/or NiW_2 in these binders. It was found that, due to the extremely low diffusion coefficient governing phase transformations in the solid state of an alloy, the annealing times used in these experiments (720 h at 800 °C and 1680 h at 575 °C) was several orders of magnitude too short to permit the peritectoid reaction α + γ→(Ni,Fe)W from going to completion, and so only the metastable nickel-based γ solid solution is observed. References 7: 4 Russian, 3 Western; figures 1; tables 2.

Development of New Equipment for Metallurgical Production of Heavy Nonferrous Metals

917D0062A Moscow TSVETNYYE METALLY in Russian 09, Sep 90 pp 21-26

[Article by B.Ye. Stepanov, Chief, and Ye.S. Gnatovskiy, Head Metallugist for Gintsvetmet Institute's Special Design Bureau for Heavy Nonferrous Metals (SKBTsM); under the rubric "Metallurgy: Heavy Nonferrous Metals: Thirtieth Anniversary of the SKBTsM at the Gintsvetmet Institute"]

UDC 669.2/.8.002.51

[Abstract] The authors discuss new equipment that has been developed by the Gintsvetmet Institute SKBTsM, the technical problems that were overcome in their design, locations where they have been successfully introduced and state prizes awarded for these designs, in the following areas: Vanyukov smelters and other low-waste processing methods; computer-aided and automated electrolyzers and equipment for deposition of galvanic coatings and foils; high productivity furnaces and converters; and automatic lines and machines for auxiliary operations. Number of patents granted has increased from 15 during the Tenth 5- Year Plan to 39 over the latest five-year plan. Leading specialists who have received awards or other recognition for their work at the Institute are identified. The need for increased diligence and output by the SKBTmM is stressed; is it proposed that cooperation with machine building enterprises be increased and in-house machine building capabilities (at the pilot plant in Ryazan) be upgraded.

Temperature and Interphase Density Fluctuations of Magnesium in the Liquid and Solid State

917D0062B Moscow TSVETNYYE METALLY in Russian 09, Sep 90 pp 65-67

[Article by S.V. Stankus and R.A. Khayrulin]

UDC 669.721:531.75

[Abstract] The authors experimentally measured the density and thermal expansion coefficient of solid and liquid magnesium in the 293-1100 K range by passing a narrow monochromatic beam of gamma rays through the sample, in hopes of obtaining more accurate data than that currently available in the literature. This method obtained room temperature densities with less than 0.05 percent error. The density at the melting point was found to be 1557+/-7 kg/m^3, and the thermal expansion coefficient was less than .00012 K^{-1}. References 11: 6 Russian, 5 Western; figures 1; tables 2.

Interaction of Zirconium and Titanium Chlorine Derivatives With Nitrogen Dioxide

917D0062C Moscow TSVETNYYE METALLY in Russian 09, Sep 90 pp 67-69

[Article by S.A. Vasilyev and A.N. Zelikman]

UDC 669.29.094.4

[Abstract] The authors investigated the interaction kinetics of nitrogen dioxide with $Zr_2O_3Cl_2$ in the 50 to 300 °C range (limited by the $ZrCl_4$ sublimation temperature), and of nitrogen dioxide with titanium tetrachloride vapor in the 140 to 650 °C range. For the former case, it is proposed that the reaction proceeds in the following way: chemisorption of NO_2 on the particle surfaces; formation of an activated complex; decay into (monoclinic or tetragonal) ZrO_2, NOCl and Cl_2. For the latter case, optimal conditions were found for producing titanium dioxide with less than 0.02 percent residual chlorine. References 4 Russian; figures 4.

Investigations on Obtaining Silicon Single Crystals Using BeO Crucibles

917D0062D Moscow TSVETNYYE METALLY in Russian 09, Sep 90 pp 73-75

[Article by R.V. Kritskaya, A.V. Suslov and B.L. Shklyar]

UDC 621.315.592:548

[Abstract] A 20 mm diameter [111] silicon single crystal free of dislocation structures was successfully grown by the Czochralski method in a 500 cm^3 BeO crucible. The specific electrical resistance distribution and optical transmission spectrum were found. The concentration of beryllium acceptor impurities was found to be roughly 10^{16} cm^{-3}, and there is a lower oxygen concentration here than in the case of a quartz crucible. IR spectroscopy methods for measuring the concentration of deep impurities (more than 0.15 eV) are discussed. References 6: 4 Russian, 2 Western; figures 2; tables 1.

The Effect of Temperature and Gaseous Environment on the Sag of a Spiral Filament

917D0062E Moscow TSVETNYYE METALLY in Russian 09, Sep 90 pp 86-89

[Article by V.V. Yevstifeyev, L.G. Kabakova, A.A. Kalkov, M.A. Tulametov and A.A. Shegay]

UDC 621.32.932.32

[Abstract] A tight-spiral tungsten filament 56 μm in diameter made by UzKTZhM was experimentally studied to determine the effect of hardness of vacuum, presence of oil vapors and inert gases, and high temperature on its ability to maintain its shape. The filaments are classified as "brittle" or "plastic" and their deflection over an average length, residual deformation under cyclic loading, and relative elongation were measured. It was found that the sag of the filament increases as the vacuum softens, and the maximum temperature is reduced. Inert gases lead to a significant increase in the sag as compared to hard vacuum. The presence of oil vapors embrittles the filament and degrades its mechanical properties. References 1 Russian; figures 4; tables 1.

On the Problem of Improving Electrolytic Production of Heavy Nonferrous Metals

917D0063A Moscow TSVETNYYE METALLY in Russian 10, Oct 90 pp 31-33

[Article by G.N. Shivrin and V.D. Lebedev, Gintsvetmet]

UDC 669.2/.8

[Abstract] The authors formulate the goal of utilizing the latest in science and technology to develop new processes for production of heavy nonferrous metals that is high in quality, economically efficient and ecologically safe. They point out the following areas in need of further study: electric extraction of metal powders, foils and bars from aqueous acid solutions; chemical reduction of metals from pressurized aqueous hydrogen solutions, with the product being pure metal powders; and case hardening of more electropositive metals from aqueous solutions with electronegative ones (zinc, aluminum, iron, etc.). There are two approaches to future improvement in commercial production of nonferrous metals: mechanization of manual labor and other operations using conventional techniques, and "machine electrolysis", a continuous rather than intermittent automated electrolytic process that almost completely prevents contact with outside air. The editors note in a postscript that there is no estimate of the economic effect of machine electrolysis, an omission that will be rectified in the next issue, and they call on readers for their responses to the issues raised in this article.

Optimizing Electrolyte Composition in Electrolytic Refining of Copper

917D0063B Moscow TSVETNYYE METALLY in Russian 10, Oct 90 pp 42-43

[Article by V.V. Puzakov, G.P. Miroyevskiy, D.G. Medikhanov and Yu.Ye. Kudryashov]

UDC 669.2.054.7:661.185

[Abstract] This study investigates the specific electrical conductivity of copper-containing sulfate electrolytes as a linear-regressed function of temperature, H_2SO_4, nickel and copper content with the goal of identifying that portion of specific power consumption governed by the ohmic voltage drop in the electrolyte. The result is a set of nomographs that may be used for minimizing electric power consumption in electrolytic copper refining processes with respect to these variables.

Hydrolytic Cleaning of Nickel Anolyte From Iron at the Severonikel Combine

917D0063C Moscow TSVETNYYE METALLY in Russian 10, Oct 90 pp 44-45

[Article by V.B. Spivakovskiy, L.P. Moysa, L.G. Trinza and L.G. Makovskaya]

UDC 66.093.8:546.72

[Abstract] Research was carried out at Severonikel Combine laboratories on controlling the residual concentration of iron in solution after precipitation of $Fe(OH)_3$ and the content of water-insoluble nickel in the ferrous filter cake, which are two important indicators of the success of cleaning nickel anolyte from iron by oxidizing Fe (II) with atmospheric oxygen and neutralizing the hydrolysis acid with nickel hydroxycarbonate. Small-scale tests indicated a solubility product of (3.4 +/- 0.8) x 10^{34}, and showed that the precipitate composition as a function of residual Fe^{3+} content in the anolyte is described by the Freudlich equation. More precise values of the solubility product of $Fe(OH)_3$, and coefficients in the Freudlich equation will have to be obtained before the process can be ramped up to a full production scale. References 3 Russian; tables 2.

Dynamic Characteristics of the Exterior Surfaces of Silicon Crystals Grown by the Czochralski Method

917D0063D Moscow TSVETNYYE METALLY in Russian 10, Oct 90 pp 76-89

[Article by A.A. Dmitriyeva, V.S. Leybovich and A.I. Pogodin]

UDC 669.783:621.315.592.002

[Abstract] The authors studied the dynamics of the exterior surface of a [111] silicon single crystal under perturbed conditions and found a delay of 3 to 5 minutes between the relative motions of the isothermal and singular surfaces. The perturbations include sudden increase and periodic variation in the rate of melt pulling, rotary velocity of the crucible, and temperature of the heater. The dynamic characteristics were deduced from optoelectronic measurements of the position of the radiation ring on the meniscus surface. It is pointed out that this method may also be employed for monitoring surface defects in the crystal as it grows. References 3 Russian; figures 4.

Formation of Supersaturated Solid Solutions of Carbon in Nickel and Cobalt During Melt Hardening

917D0060B Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian 06, Dec 90 pp 88-91

[Article by V.S. Kraposhin, USSR Academy of Sciences Problems of Microelectronics and High-Purity Materials Technology Institute]

UDC 621.7

[Abstract] The author measured the lattice constant of solid solutions of carbon in Group VIII metals (1 to 6 mass percent C in Ni- C, Co-C and Fe-C alloys) obtained by hardening, and from this calculated the degree of carbon supersaturation in the solid solution so as to correlate it with the stability of the carbide phase in the system. The samples were hardened by exposing them to IR radiation from a CO_2 laser for anywhere between 10 milliseconds and 0.5 microseconds, causing melting and hardening at rates from 10^4 to 10^7 °/sec. The phase content and carbon concentration were also determined by from x-ray photography. A linear relationship is found between the magnetic moment of the transition 3d metals and the melting point of the corresponding carbide. It is found that the supersaturated solution may arise from thermodynamic as well as kinetic factors. References 10: 8 Russian, 2 Western; figures 2; tables 1. COPYRIGHT: "Izv. vuzov. Tsvetnaya metallurgiya" 1990

Structure of Ni-Zr-Ti Triple Alloys Over the TiNi-ZrNi Section

917D0060A Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian 06, Dec 90 pp 85-87

[Article by V.N. Yeremenko, Ye.L. Semenova, L.A. Tretyachenko and Z.G. Domatyrko, UkSSR Academy of Sciences Problems of Materials Science Institute]

UDC 669.01.24'295'296:669.017.3

[Abstract] The authors used microstructure photographs, differential thermal analysis, and x-ray spectral analysis to study phase equilibrium along the TiNi-ZrNi section in 14 different alloys cast and annealed under a variety of conditions. There is some indication from the microstructure analysis that the δ_1 phase is formed in the peritectic reaction $L+\delta_2 \rightarrow \delta_1$ in a narrow temperature range at around 1160 °C. The salient feature of the system is the minimum in alloy melting temperature of 1100 °C for 25 at. percent zirconium content. It is found that the high-temperature δ_1 phase is stabilized by as little as 6 at. percent Zr δ_1 at room temperature. Alloys with between 6 and 25 percent Zr annealed at 700 °C have but one phase with CsCl structure and lattice parameter of between 0.3035 and 0.3080 nm. Substituting titanium for the zirconium in ZrNi reduces the lattic period somewhat. References 7: 2 Russian, 5 Western; figures 3; tables 1. COPYRIGHT: "Izv. vuzov. Tsvetnaya metallurgiya" 1990

Increasing the Quality of Refractory Magnesia Ore by Enrichment

917D0064A Moscow OGNEUPORY in Russian No 10, Oct 90 pp 18-20

[Article by V.G. Rogozina, N.I. Baranovskiy and N.V. Bortnikova, Uralmekhanobr Institute]

UDC 622.7.017.2:666.762.3

[Abstract] The impurities concentrations in various grades of refractory magnesia ore from the Satkinskiy deposits are discussed; these impurities include dolomite, calcite, chlorite, quartz, iron, etc. A method for removing them from a heavy suspension has been introduced at the Magnezit Combine which uses a drum separator for coarse enrichment of magnesite 150 to 60 mm in size, and a conical separator for particles 60 to 8 mm in size. The advantages of a photometric rather than a gravitational method are discussed. A method for flotation separation of fractions less than 8 mm in size (which makes up 20 percent of the raw ore) is proposed and its effectiveness studied. These methods yield magnesia concentrate with up to 96 percent MgO content. References 3 Russian; figures 1; tables 2.

Lightweight Corundum Refractory Materials With Improved Thermal Insulation Properties

917D0064B Moscow OGNEUPORY in Russian No 10, Oct 90 pp 24-26

[Article by Ya.Z. Shapiro, Ye.Ye. Starolat, Refractory Materials SRI [Ukraine]]

UDC 666.762.11-127.2

[Abstract] This study is preparatory to obtaining an improved thermally-insulating lightweight corundum refractory material. Samples were prepared from grade G-00 aluminum oxide and from 3 to 15 percent polystyrol fractions of less than 2-3 mm in size. The mixture was moistened with a solution of 1.010 to 1.023 g/cm^3 lignosulphate, dried into blanks in heated chambers for several days, then annealed. The apparent density, ultimate strength, thermal conductivity and bulk shrinkage were determined as functions of the polystyrol content and fraction in the mixture, and annealing temperature. As a result of this research, it is deemed possible to obtain lightweight corundum materials based on alumina and polystyrol with compression ultimate strength of 14.0 to 0.8 N/mm^2, annealing shrinkage of 29 to 38 percent, apparent density of 0.40 to 1.00 g/cm^3, and thermal conductivity of 0.16 to 0.54 W/(m K) (at 350 °C average temperature, 600 °C on the hot side). Figures 4; tables 1.

New Refractory Materials for Furnace Brick Linings

917D0064C Moscow OGNEUPORY in Russian No 10, Oct 90 pp 37-41

[Article by S.R. Zamyatin, K.V. Vorobyeva, D.A. Startsev, N.Zh. Garayeva, R.G. Isakova and L.I. Stokrotskaya, VostIO [Eastern Refractory Materials Institute]

UDC 666.762:621.783.2-2-033.76

[Abstract] The authors compare the tested properties and uses of various kinds of refractory concrete and other materials for use in lining the furnaces used in steel rolling and metallurgy installations. Recommendations are made on the best grades of concrete for use in various applications. Preassembly can significantly decrease the time needed for lining replacement, especially double-layer linings; VostIO and VNIIMT have developed some prototype linings, manufactured at the Semiluks Refractory Materials Plant and installed in conduits in the Red October Metallurgical Factory. The properties of MShBP and MMKBP aluminasilicate plastics are also compared to Ramtite 25 and 60, manufacture by Combustion Engineering Inc. (US). References 4: 3 Russian, 1 Western; tables 2.

Production of High-Temperature Superconducting Ceramic

917D0097A Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 6-8

[Article by P. M. Pletnev, candidate of technical sciences, V. I. Vereshchagin, doctor of technical sciences, V. Ye. Fedorov, M. G. Korpachev, A. I. Korpacheva, V. Z. Gindurlina, candidates of technical sciences, Yu. I. Mironov, candidate of physical-mathematical sciences, Novosibirsk Institute of Construction Engineering; Institute of Petrochemistry, Siberian Division, USSR Academy of Sciences; Tomsk Polytechnical Institute]

UDC 666.65:537.912

[Abstract] A study is made of the specifics of producing products of high-temperature superconducting ceramic in the system Y_2O_3-BaO-CuO by a technological cycle including grinding, synthesis, molding and sintering. The temperature interval of synthesis is 900-950°C. The most uniform reaction product was produced by the use of a granular charge. Specimens were heat treated in a tubular furnace for 1.5-2 hours at the maximum temperature with rather rapid heating and cooling at 6-8°C/min. Shrinkage was found to be quite dependent on the synthesis temperature, allowing the dilatometric method to be used to evaluate specimens. X-ray phase analysis indicates that heating to 935°C for 1.5 hours achieves a virtually uniform structure of the rhombic modification of the 1.2.3 compound with clear diffraction maxima. Figures 5; References 5: 1 Russian, 4 Western.

Ceramic Masses With Assigned Properties

917D0097B Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 9

[Article by G. S. Popenko, candidate of technical sciences, M. I. Ryshchenko, doctor of technical sciences, G. V. Lisachuk, candidate of technical sciences, N. G. Olefirenko, engineer, Kharkov Polytechnical Institute imeni V. I. Lenin]

UDC 666.635

[Abstract] In order to develop a mathematical model of the variation of sintering on chemical composition and process parameters, compositions were developed for ceramic tiles containing various sintering intensifiers and clay. Both traditional intensifiers and previously unused substances such as open-harth slag, cake, etc. were used. The ceramic tile specimens were roasted at 900, 950, 1000 and 1050°C. An equation was developed for water absorption of the ceramic tiles as a function of roasting temperature and chemical composition. The correlation coefficient of the equation is 0.806. A computer program has been developed to compute the degree of sintering of a charge to be used to manufacture ceramic products.

Anortite-Containing Ceramic Materials

917D0097C Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 10-12

[Article by Ye. Ya. Medvedovskiy, candidate of technical sciences, F. Ya. Kharitonov, doctor of technical sciences, All-Union Scientific Research Institute of Electroceramics]

UDC 666.65

[Abstract] A study is made of ceramic materials (USSR author's certificate number 1498737) in the following charge compositions (%): 25-45 calcium-containing component, 40-60 clay-containing component, 10-20 alkaline aluminosilicate melt. The content of the components is selected so that in the process of roasting the material anortite can be formed at a low temperature, while the ceramic mass has good plastic properties. Optimal properties are obtained with a specific press pressure of 30 MPa. The electrical installation properties of the ceramic produced are superior to those of traditional low-voltage porcelain at normal and elevated test temperatures. The materials can be used for various low-voltage products and for the manufacture of construction products such as tiles, and also as implantates—bones, teeth. References 5: 4 Russian, 1 Western.

Combined Nondestructive Testing of Ceramic Products

917D0081A Sverdlovsk DEFEKTOSKOPIYA in Russian No 10, 90 pp 81-84

[Article by V. M. Baranov, S. M. Yermolayev, L. M. Zhukova, Ye. M. Kudryavtsev, V. V. Kozlov, A. N. Samokhvalov, Moscow Engineering-Physics Institute]

UDC 534.16+621.039

[Abstract] A description is presented of a combined method of testing of ceramic products based on combined application of ultrasonic resonant spectroscopy and gamma-absorption radiometry. The distinguishing feature of the method is that by combined processing of the results of measurements by the two methods used it becomes possible to establish both the presence and the type of defects. Determination of the type of defect is particularly important in determining the influence of the parameters of the manufacturing process on the quality of ceramic products. Ceramic products are first tested by ultrasonic resonant spectroscopy, determining frequencies which are not present in the spectrum of a defect-free standard, indicating distortion of the field of dynamic stresses by defects in the material. The gamma-absorption method is then used, with a narrowbeam of gamma quanta transmitted through the object zone by zone to determine the mean density of the material in each zone, thus locating cracks, inclusions and cavities. The use of the method is illustrated on the example of testing cylindrical products made of oxide ceramics. The method can be performed using series-produced equipment. Figures 3; References 6: 5 Russian, 1 Western.

Process for Producing Corrosion-Resistant Corundum Ceramic

917D0097D Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 12-13

[Article by S. V. Tishchenko, engineer, Kharkov Polytechnical Institute imeni V. I. Lenin]

UDC 666.762.11:620.193.4

[Abstract] A study is made of the sintering conditions and properties of products based on corundum in ethyl silicate binder in order to decrease the roasting temperature required for the products by the use of borax, magnesium borate and various methods of introducing the ethyl silicate. The thermodynamic characteristics were computed for a number of possible chemical reactions in the system Na_2O-B_2O_3-SiO_2-$Al_{2\rangle reset}O_3$. It was found that the most probable reactions occur at over 550°C, forming aluminum tetraborate and sodium disilicate. The liquidous curves were computed and minimum melting point determined the eutectic temperature was about 450°C. The initial material was ground to a particle size of less than 63 μm to reduce the sintering temperature. Satisfactory properties were achieved at 1350°C. X-ray phase analysis indicated that in addition to the main phase of corundum there were also peaks corresponding to mullite, due to the presence of corundum with mullite structure.

Structural Carborundum Ceramic With High Crack Resistance

917D0097E Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 16-17

[Article by G. D. Semchenko, engineer, Kharkov Polytechnical Institute imeni V. I. Lenin]

UDC 666.762.8

[Abstract] The task of this study was to improve the strength and crack resistance of hot-pressed silicon-carbide-based ceramic by using elements of the sol-gel method in preparation of the mass. The silicon carbide was ground in ball mills with the addition of a modifying

substance to achieve a high degree of uniformity of the silicon carbide. The charges were prepared by mixing the components in a ball mill. The specimens were obtained by hot pressing at 2050-2100°C, 30 MPa in graphite forms coated with silicon nitride. Sintering additives were Al_2O_3 and B_2O_3 at 4:0 to 4:1. Introduction of the sol-gel binder facilitates mullitization by interaction of corundum with the amorphous ultradispersed silica. Under certain conditions β-SiC fibers were formed of the binder components with homogeneous structure and high strength of the material. The most crack-resistant material was obtained from modified silicon carbide, a densely packed conglumerate of small homogeneous silicon carbide grains with theoretical density.

Granulated Foam Glass From Glass Scrap

917D0097F Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 22

[Article by L. B. Smirnova, engineer]

UDC 666.1.036.6:666.11.004.82

[Abstract] In 1985 an experimental installation was created for the production of granulated foam glass. A year later an industrial installation producing 400 m^3 of glass foam per year was opened. This fully satisfied the demands of collective farm construction teams for insulation. The production system is based on the use of series-manufactured agricultural transportation and process equipment with some slight modifications plus the use of nonstandard equipment manufactured in the collective farm mechanical shops. Scrap glass is crushed to 5000-6500 cm^2/g specific surface in ball mills with up to 4% carbonate gas-forming compound and 0.5-0.6% carboxymethyl cellulose. The granules are formed on a plate-type granulator, dried with hot air in a screen-belt drier at 300°C, then foamed in a rotating furnace of 790-840°C for 8-10 minutes.

Mechanization of Loading of Granulate in Molds on Glass Crystal Tile Production Lines

917D0097G Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 23

[Article by Yu. V. Grishin, chief designer, V. D. Chernyshov, senior engineer-designer]

UDC 666.263.2-41

[Abstract] The glass plant imeni Dzerzhiniskiy has developed mechanized lines for production of glass-crystal tiles with a capacity of 80-85,000 m^2 per year, with cars of tiles leaving the furnace each four minutes. A crank-lever mechanism is used to fill the molds on the trucks with granulate. The economic effect of the bulk material loading device is 24,500 rubles for a production volume of 150 m^2 per year. Product quality has also improved and the rate of consumption of raw materials decreased. A diagram of the device is presented.

Nonfritted Aegirite Glaze for Sanitary Ceramics

917D0097H Moscow STEKLO I KERAMIKA in Russian No 12, Dec 90 pp 24

[Article by V. I. Voyevodin, engineer]

UDC 666.295.4:666.643.5

[Abstract] There is a shortage of raw materials, particularly high-quality ones, for the manufacture of sanitary ceramic products. This problem is being solved by replacing traditional raw materials with new types of natural and synthetic materials utilizing the wastes of other processes. To decrease the cost of colored sanitary products in dark colors, the Kuybyshev "Stroyfarfor" plant has worked to reduce the quantity of dye introduced to glazes and improve the distribution and shine of the glaze. Aegirite concentrate ($NaFeSi_{12}O_6$) from a mining and beneficiation combine has been used as inexpensive, plentiful and highly effective shine intensifier for ceramic glaze. The chemical composition of the concentrate is (%): 43.47 SiO_2, 26.80 Fe_2O_3, 10.00 Al_2O_3, 3.60 CaO, 2.46 MgO, 10.55 Na_2O, 1.25 K_2O. The use of the aegerite concentrate allows the production of good-quality glazes while decreasing the consumption of ceramic dyes. The economic effect of use of one ton of aegerite glaze for production of sanitary ceramics is 470 rubles.

Development of Computer Photomicrography for Analysis of Composite-Material Products

917D0081B Sverdlovsk DEFEKTOSKOPIYA in Russian No 10, 90 pp 84-90

[Article by V. I. Lelekov, V. G. Pykhtin, Ya. G. Smorodinskiy, Moscow Institute of Electronics; Institute of Metal Physics, Urals Division, USSR Academy of Sciences]

UDC 620.179.15

[Abstract] Studies on computer-controlled photomicrography have been conducted in the x-ray, neutron, ultrasonic, helicon and NMR areas, but x-ray computer-controlled photomicrography has been most developed. The statistical testing or Monte Carlo method allows the creation of comparatively simple programs to compute the fluxes of particles and related integral and differential parameters of the areas in the product being tested. An automated computation system has been developed to determine the coefficients of the Boltzmann equation which must be solved to determine the spatial, angular and energy distributions of the radiation in a computerized tomography system for small composite products. A diagram of the microtomograph is presented. The device can detect defects as small as 3 μm. Figures 3; References 7: Russian.

Formation of Camber on Rails After Rolling

917D0116B Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 90 pp 34-36

[Article by S.N. Kudrin, G.A. Chervov, V.V. Kazakov, N.A. Chelyshev, A.R. Trynkin, and V.F. Tsarev, Siberian Institute of Metallurgy]

UDC 621.771.26:621.982

[Abstract] Production of rails adequate for high-speed trains is considered, a major problem being formation of camber on the upper flanges after the rolling operation. A stress analysis based on the force distribution in the finishing pass reveals that both head and foot of a rail, being wide, deform differently than the thin web. The integral profile of residual stresses, based on vertical equilibrium $2x\text{Int}_0^{h/2}\sigma_x dy = 0$ and the hypothesis of plane sections, shows compressive stresses in the rail head and in the rail foot. These stresses decrease from maximum at the top surface of the head and at the bottom surface of the foot to zero in the neutral planes within the respective transition zones to tensile stress in the web, this stress then increasing to a maximum in the centroidal plane. After completion of the rolling process, 52 m long blooms are cut in two and defective tips at both ends of each are cut off. Within the zones of maximum compressive stress, at both top and bottom surface, there consequently appear free surface segments where these stresses relax. Inasmuch as the maximum stress is not allowed to exceed the elastic limit for the rail material, any change in stress will result in strain according to Hooke's law. A further analysis based on numerical data on the rolled-steel rail sections reveals that camber develops during the cutting operation, no matter by what method. It can be avoided only by plastic deformation around the entire contour, which in the case such a large and heavy item is possible only by rolling in a universal four-roll pass with heavy lateral edging. Figures 2; tables 1.

Heat Transfer during Interaction of Water-Air Stream and Surface of Continuously-Cast Ingot

917D0116A Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 90 pp 12-14

[Article by V.Ya. Gubarev, Ye.A. Mosin, O.N. Yermakov, V.I. Lebedev, and V.P. Loginov, Lipetsk Polytechnic Institute and Central Scientific Research Institute of Ferrous Metallurgy]

UDC 669.18:621.746.047

[Abstract] Processes and particularly heat transfer taking place during interaction of a continuously-cast ingot and a water-air stream striking its surface at right angles are analyzed theoretically, considering that such a stream containing small water droplets behaves like a single two-component fluid with aerodynamic drag forces dominating over inertia forces. Based on practical estimates regarding the aerodynamic drag and impact on a hot surface, a model of the heat transfer mechanism is proposed according to which a single-phase gaseous boundary layer forms and then interacts with the two-phase stream. The subsequent temperature distribution in the stream is evaluated on this basis, considering that an appreciable temperature difference between air and water droplets builds up. The analysis then proceeds with the following three assumptions: laminar flow, uniform distribution of water droplets in the stream, and purely conductive heat transfer through the air. A system of three differential equations with appropriate boundary conditions has been set up, for the air-water temperature difference and its gradient and for the size of water droplets (diameter cubed) as functions of the normal coordinate across the boundary layer. This system of equations was solved for the initial conditions of a 100°C temperature of water droplets in the stream, disregarding the amount of heat extracted from the ingot for raising their temperature to that level, and a 1100°C temperature of the ingot temperature. The variables were velocity of the oncoming stream, diameter of the water droplets, and weight fraction of water in the stream (relative density of the water-air mixture). It was solved by the method of finite differences on a Standard System 1022 computer. The results indicate that the temperature distribution in the stream does not depend on the stream velocity over a wide range (2-20 m/s) of the latter and is characterized by an exponential profile with a steep rise within a narrow region (0.5-5 mm) adjacent to the boundary layer. They also indicate that the principal factors influencing the temperature distribution in the air phase of the stream and the temperature gradient at its interface with the boundary layer are the weight fraction of water and the diameter of water droplets, the latter not appreciably increasing (only 0.1-6 %) across this region owing to evaporation during passage of the stream through it. The heat transfer coefficient at that interface was calculated accordingly, disregarding convective heat transfer through the air phase but considering its dependence on the diameter of the water droplets as well as on the thickness of the boundary layer. An experimental study of such cooling of a cast ingot was made in a test stand which included a mixing chamber with coaxial water and air intakes and various flat-jet sprayer nozzles. The fair agreement between values of the heat transfer coefficient based on measurement and on calculation respectively confirms that the optimum diameters of water droplets in the stream would be 20-50 μm. Droplets larger than 0.1-0.5 mm modify the heat transfer to one characteristic of plain water cooling. Figures 3; references 2.

Dependence of Properties of Aged Martensitic Stainless Steels on Heat Treatment Parameters

917D0116C Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 12, Dec 90 pp 50-52

[Article by S.I. Krasnikova and A.S. Gladkiy, Dnepropetrovsk State University]

UDC 669.046:621.785.616:620.17

[Abstract] Considering that the most flexible method of treating martensitic steel so as to ensure a combination of high impact strength at cryogenic temperatures and high tensile strength at normal temperatures is quenching it from a temperature somewhat above Ac_3 and subsequent aging at a temperature slightly below Ac_1, a study of 03Cr(P)Ni8Co9Mo5T steel was made for establishing the dependence of its structure and mechanical properties on such a the heat treatment. Specimens of this steel, rods 10 mm in diameter with a transverse grain orientation, were structurally refined by a preliminary heat treatment: quenching twice from 980°C after heating to that temperature at 10°C/min. This removed TiC which had precipitated along grain boundaries during cooling after hot deformation and also produced a fine-grain microstructure of a single grain size fraction. The final heat treatment was varied, its four parameters influencing those two key mechanical properties being varied for a 4-factorial 3-level experiment according to the Box-Benken symmetric rotatbale noncomposite plan: temperature of final quenching from 750°C to 850°C, aging temperature from 540°C to 580°C, rate of heating to quenching temperature from 5°C/min to 15°C/min, aging time from 1 h to 3 h. The specimens were tested for tensile strength at a normal temperature according All-Union State Standard 1497-84 and for impact strength at a low temperature of -70°C according to All-Union State Standard 9454-78. As five dependent parameters, strength and plasticity indicators, were selected: ultimate strength, 0.2 % yield strength, percentage elongation, percentage reduction, KCU_{-70} (J/cm^2). The data of 27 runs have been evaluated with the aid of a DVK-3 microcomputer, a regression analysis having yielded system of two first-degree and three second-degree equations. The results indicate that the optimum heat treatment for an ultimate static tensile at normal temperature not lower than 1600 N/mm^2 and an impact strength at -70°C not lower than 35 J/cm^2 is quenching from 800°C and aging at 560°C for 2 h. Only about 12.5 % austenite, mostly secondary and some residual, was recorded in the microstructure after such a heat treatment. Figures 3; tables 2; references 9.

Low-Alloy Steel With High Corrosion and Cold Resistance

917D0117C Moscow STAL in Russian No 11, Nov 90 pp 77-80

[Article by B.Z. Belenkiy, S.G. Ryskina, A.L. Yegorov, G.S. Arzamastseva, N.A. Fomin, R.S. Ayzatulov, and V.S. Zubakov, Ural Scientific Research Institute of Ferrous Metallurgy, Kuznetsk and West Siberian Metallurgical Combines, and Guryev Metallurgical Plant]

UDC 669.15.2.194+669.14.018.41+620.193.23

[Abstract] The technology developed by the Ural Scientific Research Institute of Ferrous Metallurgy for producing rolled stock of 08CrMnSiCu-R was put into practice for a final evaluation, with the assistance of Kuznetsk, Nizhniy Tagil, and West-Siberian Metallurgical Combines. Batches of this steel were made in two basic open hearth furnaces (210-ton, 425-ton) of the Kuznetsk Metallurgical Combine and in two acid converters (160-ton, 350-ton), the one of the Nizhniy Tagil Metallurgical Combine being charged with wrought iron (2.7-3.7 % C, 0.01-0.07 % Mn) and the one of the West Siberian Metallurgical Combine being charged with pig iron ($\approx$ 4.5 % C, $\approx$ 0.5 % Mn, $\approx$ 0.7 % Si) and scrap metal. Deoxidizers were added to the crucible: either FeP16 ferrophosphorus + SiMn7 silicomanganese or FeP16 ferrophosphorus + FeSiCr33 ferrosilicochromium. The latter combination was more economical, only about 2 kg/ton being required on account of much less MnO buildup. Other ferro-alloys were added to the ladle. In order to raise the phosphorus content in the steel first to 0.02 % P, it was necessary to decrease the amount of slag-forming constituents and to lower the basicity of the slag while also raising the temperature of the molten metal to 1600- 1660°C. Its temperature was then lowered to 1540-1560°C and the alloying elements were made to distribute more evenly by a blast of argon or nitrogen entering through porous or submersible tuyeres. The final chemical analysis of the thus produced steel was according to specifications: $\leq$ 0.10 % C, 0.5-0.8 % Cr, 0.8-1.2 % Mn, 0.5-0.8 % Si, 0.2-0.4 % Cu, 0.05-0.08 % P $\leq$ 0.035 % S. Ingots were rolled into angles and I-beams of various sizes in blooming and then shaping mills of those Metallurgical Combines and also at the Guryev Metallurgical Plant. The results of mechanical tests indicate that thus produced large sections (160x100x10 mm, 140x140x9 mm) and medium-size sections exceed minimum strength and plasticity requirements with a wide margin, I-beams having the best combination of mechanical properties, and small sections (40x40x4 mm) satisfy them closely. Owing to the wide available strength margin, rolling of this 08CrMnSiCu-R steel is monitored statistically and the product is accordingly segregated into two strength classes. Sections of all sizes were tested for at -60°C and all found to have a high impact strength at this temperature. Also sections with sharp and round notches were tested, for an indication of ductile or brittle fracture, and only large sections were found to have an impact strength not higher than 29 J/cm^2 KCU at -70°C. Microstructural examination of all sections revealed 79-89 % ferrite and 21-11 % pearlite. Unequal 160x100x10 mm angles of this steel were used as replacement of 2 mm or thicker angles of 09Mn2Cu steel for open wagons and 190 kg/ton of material was thus saved, referring to the same length of service. All other angles were used as replacement of 09Mn2Si steel for supports of electrical power transmission lines, over 10 million rubles thus being saved in the year 1989 on account of the higher corrosion resistance. Figures 3; references 3.

Current Status of Production of Metal Powders in USSR and Prospects for Their Use In Economy

917D0096A Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 1-11

[Article by O. S. Nichiporenko, Institute of Material Science Problems, Ukrainian Academy of Sciences]

UDC 621.762

[Abstract] Following a description of the production of metal powders in the capitalist countries, the production in the USSR of iron, copper and aluminum powder is described. Until recently, the production of iron powder has been based on reduction of iron oxides by carbon in tunnel furnaces, combined reduction of a bulk charge in horizontal muffle furnaces and reduction of a briquette charge in vertical furnaces. The spraying method has a number of advantages, including low power consumption, high productivity and capability for automation and mechanization. This has stimulated the organization of large sprayed powder production shops at two metallurgical plants. Production of alloy steel powders by this method is also planned. Consumption of iron powder in the USSR is limited by the available quantity and quality and the shortage of the necessary equipment. Copper powder has been produced by electrolysis using soluble anodes of high-purity copper. Mass production of copper by atomization of melts with the high-pressure water or compressed air has been organized in the USSR since 1981. The consumption of copper and copper alloy powder requires the stimulation of the open market, development of the required equipment, and establishment of direct connections between powder producers and consumers. Aluminum powder is produced by physical-mechanical methods and physical-chemical methods, in which the chemical composition of the initial product is changed. The spraying method is dominant in Soviet practice, and is distinguished by its simplicity and flexibility. Fine powder is produced by dry or wet grinding of larger pieces, with dry grinding usually performed in a protective medium of nitrogen or argon, wet grinding in white spirit to prevent combustion. Inhibitors are frequently added to the liquids. Aluminum fine powder is primarily used in the manufacture of rocket fuel, pyrotechnical devices, chemical and pyrometallurgical processes. Soviet industry produces powders of other nonferrous metals such as nickel, cobalt, zinc, lead, tin and their alloys in quantities fully satisfying the domestic demand for these products. References 24: 19 Russian, 5 Western.

Production of Sprayed Metal and Alloy Powders by Rotating Electrode Method

917D0096B Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 11-22

[Article by M. Zduyich, D. Uskokoovich, Institute of Technical Sciences, Serbian Academy of Sciences and Arts, Belgrad]

UDC 621.762

[Abstract] This review of the (virtually entirely Western) literature discusses centrifugal atomization, the classical process for the production of metal powders. The basic methods of centrifugal atomization discussed include the spinning blank method, spinning disk method, and centrifugal atomization with feeding of metal from melting furnace to disk. The influence of the parameters of centrifugal melting on the properties of the powder is analyzed. Centrifugal atomization is an easily controlled process for producing powders. The mean size and distribution of particles among sizes can be easily and precisely controlled over relatively broad limits by changing the speed and diameter of the spinning element. The particle-size distribution range can be expanded for a material by increasing the melting speed. The distinguishing characteristics of centrifugally atomized powders are purity and spherical particle shape, which is important for the production of active metals and alloys in the powder state. Figures 8; References 56: 6 Russian, 50 Western.

Estimating Mixing Uniformity of Nickel-Titanium Powders

917D0096C Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 25-28

[Article by I. A. Drozdov, Kuybyshev Aviation Institute]

UDC 621.762.3:669.245

[Abstract] A study is made of the possibility of producing a high-quality mixture of powders of carbonyl nickel and titanium in the time recommended in previous studies. The powders were mixed in a 1.7 dm^3 drum mixer rotating at 45 rpm for four hours. 0.07 kg of iron fasteners was added to improve mixing. After mixing, samples were taken and separated magnetically and analyzed chemically. An algorithm and FORTRAN program are presented for computation of the mean-square error and inhomogeneity factor of a mixture produced by the method. The mixing conditions are found to achieve good homogeneity for mixing of titanium powder and very fine nickel powder. Figure 1; References 3: Russian.

Grinding of Iron Chips in Rotating Magnetic Field

917D0096D Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 36-40

[Article by B. G. Arabey, A. V. Vasilev, S. B. Kostyrev, A. P. Kolgin, A. S. Mints, D. I. Ryzhonkov, L. A. Pronin, S. A. Sopochkin, S. A. Stepnov, V. L. Esikman, "Scientific Research Institute for Tractors and Agricultural Machinery" Scientific-Production Association; Moscow Institute of Steels and Alloys]

UDC 621.762

[Abstract] The motion of a particle in a rotating magnetic field reactor is described in a polar system of coordinates with its origin at the center of the reactor. A magnetic dipole performs complex motion in the volume of the reactor from an arbitrary starting point, defined by the radial and tangential components of the velocity of its center of mass and its rotation about its center of mass. The interaction of particles in the magnetic field is analyzed, including impact of particles with the wall and impact of particles with each other. It is confirmed that

a rotating magnetic field apparatus can act on a ferromagnetic material, rapidly decreasing its particle size. Systems of this type also allow removal of nonmagnetic particles from an initial ferromagnetic material. Figures 4; References 5: Russian.

Influence of Long-Term Heating on Oxidation of Titanium Carbide Hard Alloy

917D0096E Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 41-46

[Article by V. D. Voytovich, E. I. Golovko, L. N. Beloborodov, N. N. Sereda, Institute of Materials Science Problems, Ukrainian Academy of Sciences]

UDC 621.762.5:661.65:669.29:669.245'28:543.42:536.45

[Abstract] A previous work by these authors studied the oxidation of a model titanium carbide alloy, analyzing the redistribution of the carbides and the Ni and Mo binder elements. The studies indicated that during long-term oxidation there was significant redistribution not only of the binder elements, but also the impurity elements Fe, Cr, Co and Si. This process was studied by microscopic x-ray spectral analysis of the initial material and oxidized specimens. It was found that in addition to the redistribution of the binder and carbide elements, the impurity elements are also redistributed and diffuse toward the outer phase boundary. The migration of elements with small ionic radius and low valence increases the sintering capability of the scale by decreasing the defect density and increasing the mobility of titanium cations in the routile. These processes cause oxidation to virtually halt after 21 hours in air at 1000°C. Figures 5; References 11: 2 Russian, 9 Western.

Strength of Diamond-Containing Composite Based on Tungsten Carbide Hard Alloy

917D0096F Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 64-68

[Article by D. Kh. Bronshteyn, A. L. Maystrenko, E. S. Simkin, N. V. Tsypin, Institute of Superhard Materials, Ukrainian Academy of Sciences]

UDC 62-98:621.762

[Abstract] A study is made of the conditions of production by hot pressing and the properties of a matrix material—a hard alloy with high-temperature tungsten carbide—and a diamond-containing composite based on this material. Hot pressing was performed in graphite press molds at 12.3-14.7 MPa with induction heating. The mechanical properties of prism specimens measuring 5x5x35 mm (density, hardness, flexural strength) were determined by standard methods, the wear resistance of the matrix materials by friction with a rigidly amounted abrasive, crack resistance in disk specimens 10 mm in diameter and 2.5 mm thick by a special method developed at the Institute of Superhard Materials. The coefficient of thermal expansion was measured at 290-990 K without a protective gas medium. The elasticity modulus was determined by measuring the velocity of a longitudinal elastic wave. Fractographic analysis was performed on a scanning electron microscope. The composites were found to have better mechanical characteristics than superhard materials based on alloys with low-temperature tungsten carbide, widely used in the manufacture of drilling tools today. Figures 3; References 11: 10 Russian, 1 Western.

High-Temperature Radiation Embrittlement of Magnesium-Beryllium Powder Alloys

917D0096G Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 69-72

[Article by V. F. Zelenskiy, I. M. Neklyudov, L. S. Ozhigov, V. I. Savchenko, Kharkov Institute of Physics and Technology]

UDC 539.219.3:529.56

[Abstract] A study was made of the high-temperature radiation embrittlement of a magnesium-beryllium alloy made of powders with particle diameters of 50 to 200 μm produced by milling, as well as powders of Mg-Be distillation compositions. The specimens studied were cylinders 4 mm in diameter and 20 mm in length, bombarded by beams of electrons with initial energy 225 MeV to a maximum fluence of 6×10^{18} el/cm^2 at 90°C. The specimens were then tested at 450°C at 2×10^{-3} s^{-1} deformation rate. As the fluence increases the strength of grain boundaries decreases, while the grain bodies increases. In a finite dispersed material produced by methods of powder metallurgy the length of grain boundaries is significantly greater than in a large-grain material, decreasing the specific concentration of helium on the grain boundaries and reducing the influence on grain-boundary weakening. Furthermore, very finely dispersed second-phase particles such as the intermetallide $MgBe_{13}$ can serve as centers of attachment for helium atoms or clusters, preventing the growth of helium bubbles. Although very finely dispersed particles decrease ductility, in the bombarded material helium clusters make a smaller contribution to grain hardening than in ordinary materials. Thus, the creation of materials with very finely dispersed particle distribution of the second phase can reduce the effect of high-temperature radiation embrittlement. Figures 3; References 9: 6 Russian, 3 Western.

Acoustical Characteristics of Powdered Invar Alloys. II. Change in Parameters in -100+500°C Temperature Interval

917D0096H Kiev POROSHKOVAYA METALLURGIYA in Russian Sep 90 pp 104-106

[Article by V. A. Vershinin, V. I. Kostikov, V. A. Belyanin, Yu. F. Maksimov, K. P. Nikonov, N. D. Pautkov, Yoshkar-Ola]

UDC 621.762.24:536.58.539.32

[Abstract] The acoustical characteristics of the powder alloys 36N and 32NKD were determined as a function of residual porosity between -100 and +500°C. The equipment and methods used in the experiments were described in a previous work and are not described here. The temperature variation of Poisson's ratio μ, Young's modulus E, shear modulus G and ultrasonic wave propagation velocity C_l has a complex and anomalous nature related to the invar properties with clearly expressed extremes. All the curves have singular points near the Curie point indicating breakdown of the invar anomaly when the specimens are heated, confirmed by previous studies. The good correlation of the Poisson ratio and coefficient of linear expansion indicate that an invar effect is present in the material, manifested in the anomalous behavior of the temperature variation of Poisson's ratio. Figure 1; References 7: Russian.

Putting in Production Rolled Flat Stock and Sections of Weather- Resistant Steels

917D0117A Moscow STAL No 11, Nov 90 pp 47-49

[Article by D.P. Kokushkin, R.Ya. Sharafutdinov, O.N. Soskovets, S.G. Bratchikov, V.I. Sidorkin, and D.V. Dergunov, Ural Scientific Research Institute of Ferrous Metallurgy, Karaganda Metallurgical Combine, and Ural Polytechnic Institute]

UDC 621.771.23+261:669.14.018.292

[Abstract] Two weather-resistant low-alloy steels 10CrCu-R and 10CrNiCu-R for rolled flat stock, analogs of Cor-Ten steels, have been developed by the Central Scientific Research Institutes of Ferrous Metallurgy and of Steel Construction Planning. A third such steel 15CrCu-R for rolled flat stock and rolled sections has then been added by the Central Scientific Research Institute of Ferrous Metallurgy and the Scientific Research Institute of Railroad Transportation. A steelmaking technology has been subsequently developed for production of flat stock and sections. Pilot production involved steelmaking in 600-ton open hearth furnaces with oxygen blast through cupola tuyeres and in 300-ton converters, pouring through gates into plate molds for casting into 20-ton ingots, and covering the surface with thermal insulation. Ingots were heated in pits and then rolled into slabs. Slabs of 10CrCu-R steel (≤ 0.12 % C, 0.5-0.8

Cr, ≤ 0.3 % Ni, 0.2-0.4 % Cu, 0.3-0.6 % Mn, 0.17-0.37 % Si, 0.07-0.12 % P, ≤ 0.035 % S) and 10CrNiCu-R steel (≤ 0.12 % C, 0.5-0.8 % Cr, 0.3-0.6 % Ni, 0.3-0.5 % Cu, 0.3-0.6 % Mn, 0.17-0.37 % Si, 0.07-0.012 % P, ≤ 0.035 % S) were hot-rolled into 2.5-8.0 mm thick strip and cold-rolled into 0.7-1.5 mm thick sheet. Slabs of 15CrCu-R steel for flat stock (≤ 0.18 % C, 0.8-1.2 % Cr, ≤ 0.3 % Ni, 0.15-0.25 % Cu, ≤ 0.40 % Mn, ≤ 0.30 % Si, ≤ 0.15 % P, ≤ 0.04 % S) were hot-rolled into 4.0 mm thick strip and cold-rolled into 1.5-2.0 mm thick sheet. Slabs of 15CrCu-R steel for sections (≤ 0.18 % C, 0.5-1.2 % Cr, ≤ 0.3 % Ni, 0.15-0.40 % Cu, ≤ 0.40 % Mn, ≤ 0.30 % Si, ≤ 0.15 % P, ≤ 0.40 % S) were hot rolled into 45x45x5 mm, 50x50x5 mm, and 63x63x6 mm angles. Mechanical and environmental tests have confirmed the suitability of both 10CrCu-R and 10CrNiCu-R steel for up to nine years of service in urban and industrial atmospheres. Corrosion cracking was found to cease after five years, a tight layer of corrosion products having formed on the outside surface of hot- rolled 10CrCu-R strip and cold-rolled 10CrNiCu-R sheet. By that time the roll scale on the inside surface of hot-rolled strip had completely broken down and the inside surface of cold-rolled sheet had become covered with a protective layer of corrosion products. The results of tests conducted at the Scientific Research Institute of Railroad Transportation indicate that 15CrCu-R steel corrodes 1.5 times slower than rimmed and killed St3 carbon steels in alternately wet and dry weather, also 1.1 times slower than 10CrNiCu-R steel under such conditions. Its corrosion resistance is 1.8-2.0 times higher than that of 09Mn2Si steel, its resistance to combined corrosive and mechanical wear 1.45 times higher. Small amounts of Ge added to this steel were found to still further inhibit its corrosion in humid air, by blocking active corrosion centers around its nonmetallic inclusions. Following further studies and testing of these new steels in various enterprises, they are now made at the Karaganda Metallurgical Combine from naturally alloyed cast iron containing P and scrap metal containing Cr,Ni,Cu. Their cost effectiveness as replacement of plain carbon or other alloy steels is due to weight reduction in the redesign of containers and wagons, elimination of the coating process, and longer service life. Tables 2; references 3.

Development of Technology of Producing Cold-Rolled Corrosion-Resistant Triple-Layer Strip

917D0117B Moscow STAL in Russian No 11, Nov 90 pp 62-63

[Article by L.A. Agishev and V.D. Nikitin (deceased), Chelyabinsk Metallurgical Combine]

UDC 621.771.23:621.77.016.3:669.14.018.8

[Abstract] The technology developed by the Chelyabinsk Metallurgical Combine for mass-producing T1 corrosion-resistant triple-layer steel strip, a layer of St-10 low-carbon steel clad bilaterally with 08Cr18Ni10Ti stainless steel, has been corrected so as to eliminate wide thickness variation and high carbon buildup within the contact zones. The first experimental production lot was rolled from 3.0-3.5 mm thick pickled stock, which had been produced by hot rolling with the final temperature fluctuating over the 920-980°C range and subsequent coiling at a temperature within 660-720°C. The layers had been joined by welding in an argon-arc machine (30-32 V, 200-230 A) using argon at a rate of 80-90 dm^3/min and Sv-06Cr19Ni9Ti wire. The seams, while sufficiently strong to remain intact during transport, were not sufficiently plastic for cold rolling. The stacks

were therefore first heat treated in the long tripartite furnace of an NZTA-1 continuous-duty quenching and pickling machine at 910-980°C, for 1.0-1.3 min per millimeter of thickness, and then water cooled. This process was followed by electrolytic pickling in a Na_2SO_4 solution with a current of 6.0 kA at 60°C and passivation a in 9-10 % HNO_3 + 3.8-5.6 % HF solution, however not all scale and sludge having been removed despite the much higher than standard rate of acid consumption. The stacks were then skin rolled to 1.5 % reduction, for elimination of nonplanarity. Subsequent cold rolling to produce 3-ply 2.0 mm thick and 1100 mm wide steel strip was done in a four-roll mill, in three passes under up to 15 MN compression with up to 250 kN tension. The preliminary treatment is being improved by better control of the hot rolling (lower final temperature within 900-930°C) and the coiling (lower temperature within 600-640°) of stacks, by faster cooling of coils, first at 15-30°C/h with better ventilation so as to reduce carbon buildup in the contact zones and to increase the plasticity, an by finer skin rolling to 1 % reduction only. Cold rolling to produce 3-ply 1.5 mm thick and 1130 mm wide strip after this new treatment was already tried, also in three passes: 1) reduction from 2.8 to 2.1 mm under 16.0 MN compression, at a rolling speed of 1 m/s with 150 kN pull and 120 kN back tension; 2) reduction to 1.7 mm under 15.0 MN compression, at a rolling speed of 5 m/s with 250 kN pull and 230 kN back tension; 3) reduction to 1.5 mm under 14.5 MN compression, at a rolling speed of 5 m/s with 220 kN pull and 200 kN back tension. The cold rolling operation on adequately pickled strip was sufficiently stable for maintaining thickness uniformity. Strip was thus produced having an ultimate tensile strength of 500-520 N/mm^2 , a 0.2 % yield strength of 350-380 N/mm^2, an elongation of 35-42 % in 5 cm, and also passing the 180° bend test. Figures 2; tables 1; references 1.

Production of Rails Using Universal Stand as Planisher

917D0024A Moscow STAL in Russian Jul 90 pp 64-67

[Article by A. F. Kuznetsov, V. V. Dorofeyev, I. A. Sharapov, Ye. L. Kravchenko, Kuznetsk Metallurgical Combine]

UDC 621.771.26

[Abstract] A method has been developed to roll rails using a universal stand as a planisher. The planisher line is installed 9 m from the finishing stand. The horizontal rolls are driven through a gear stand by a 4000 kW electric motor. Rails are rolled simultaneously in two stands—the universal four-roll planisher and two-roll 850 finishing stand. The first experimental run of rails was produced on the new system in December of 1986. Some 26,000 tons of type R-65 rails were produced by the new technology in 1987. A number of changes were made to the design to eliminate early run problems. Diagrams illustrate the positioning of the four rolls used in the planisher to produce standard-section rails. The reduction in the universal stand was increased to utilize the full capacity of the stand. The quality of the rails produced using the universal pass is as follows: 82-90% of all 25 m rails have no surface defects (up from 67-80% in the previous mill); mechanical properties equal to rails produced by previous technology, plastic properties somewhat superior. Experimental thermally hardened rails have greater tensile strength. Impact toughness somewhat greater. Figures 2; References 3: Russian.

New Locomotive Tire Production Technology

917D0024B Moscow STAL in Russian Jul 90 pp 67-69

[Article by A. V. Yakovchenko, V. M. Ozimin, M. I. Starosepletskiy, Donetsk Scientific Research Institute of Ferrous Metals and Nizhnedneprovsk Pipe-Rolling Plant imeni K. Libknekht]

UDC 621.771.292

[Abstract] A new wheel-rolling division includes high-power presses, requiring optimal distribution of deformations among the equipment and the creation of the most favorable conditions for formation of the flange and stabilization of metal flow during rolling. The plastic deformation during rolling of a blank with a prepared flange larger than the flange of the finished tire was studied. The excess size of the flange on the blank is very significant for determination of rolling conditions. A program has been developed for calculation of deformation conditions to achieve optimal results considering the temperature and speed parameters of the process. Profiles of the blank, rolled product after roughing stand and tire produced on finishing stand are presented. Figures 2.

Increasing Accuracy of Drawing on Continuous Wire Mill

917D0024C Moscow STAL in Russian Jul 90 pp 69-70

[Article by A. A. Tolpa, S. V. Kalinovich, E. P. Nikolayev, Yu. I. Morozov, V. S. Sapelkin, Donetsk Scientific Research Institute of Ferrous Metallurgy; Makeyevo Metallurgical Combine]

UDC 621.778.002.64:658.018

[Abstract] In order to maximize the stability of dimensions of rolled products heading for the finishing group of stands in a wire mill, it is suggested that a box oval-circle sequence of passes be used in the roughing and intermediate groups of stands of a continuous mill. This type of pass is universal and allows rolling of an intermediate circular shape if required. This system was tested in rolling of circular steel 6.5, 8.0, 10 and 16 mm in diameter on a laboratory mill. The box oval-circle plan increases the stability when the rolled product is transferred between stands. Ovality was reduced by 0.1-0.15 mm and the length of the metal with distorted profile geometry at the rear end was reduced to 5-8 m. Figure 1.

Surface Hardening Using Low-Temperature Plasma and Ultrasound

917D0098B Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian Sep 90 pp 9-12

[Article by Kh. M. Rakhimyanov, G. A. Iskhakova, Novosibirsk, Institute of Electrical Engineering]

[Abstract] Results are presented from a study of the surface layer formed with plasma thermal hardening and subsequent ultrasonic plastic deformation of the specimens which had been hardened using the energy of a low-temperature plasma, forming a surface layer up to 0.6-0.65 μm thick. The ultrasonic deformation of the surface layer changes the qualitative characteristics of the material. The microhardness was studied through the depth of the surface layer as well as over its area. Ultrasonic deformation increases the hardness and makes it more uniform over the surface area. The use of ultrasonic plastic deformation after plasma hardening of steel parts forms a surface layer with superior mechanical and geometric characteristics, improving usage properties. Figures 4; References 3: Russian.

Hardening of Parts in Magnetically Fluidized Bed

917D0098D Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian Sep 90 pp 25-31

[Article by D. A. Ignatkov, V. P. Goncharuk, Institute of Applied Physics, Moldovan Academy of Sciences]

[Abstract] The effectiveness of a magnetically fluidized bed for working and hardening of parts has been demonstrated in a number of machine-building processes. In this method a stochastic set of ferromagnetic asymmetrical particles is accelerated by an external magnetic field

to produce the fluidized bed. As the particles impact the surface of a part suspended in the bed it is deformed and hardened. This processing occurs in a few minutes, thus increasing productivity. Cylindrical specimens of several types of steel were exposed to the fluidized bed to construct mathematical models considering the influence of the concentration of particles, magnetic induction, length and diameter of the cylindrical particles of high-carbon wire of which the bed was composed and treatment time on surface roughness and hardness, as well as fatigue strength. Equations are derived for determination of optimal conditions for hardening of parts of the various types of steels tested. The selection of optimal process conditions can increase the hardness of the surface layers and the endurance and other usage characteristics of the parts. Figures 5; References 10: Russian.

Reactions of Molybdenum With Cobalt and Cerium at 773 K

917D0083B Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 3, Apr 90 pp 87-90

[Article by N.I. Kaloyev and R.V. Kalagova, Severo-Osetinsk State University, Department of Inorganic and Analytical Chemistry]

UDC 669.25'28'651

[Text] A study of the Co-Mo-Ce system in the Co-rich corner was made with the aim of replacing expensive Sm with cheaper Ce in permanent magnets. Eighty-six Co-Mo-Ce alloys were melted from electrolytic metals in an electric arc furnace with a nonconsumable tungsten electrode in argon atmosphere. The alloys were homogenized by annealing for 1000 to 2500 hours at 773 or 1273 K, quenched into ice water from 773 K, and studied by metallography, x-ray diffraction, x-ray spectrometry, and hardness measurement. The phases were identified with the aid of ASTM charts and literature data pertaining to the phases existing in the Co-Ce and Co-Mo binary systems. The results of the study were used to construct the 773 K isothermal section of the Co-Mo-Ce system in the Co-rich corner. The existence of Ce2Co17, CeCo3, Ce2Co7, CeCo2, CeCo3, Ce24Co11, Co3Mo, and Co7Mo6 intermetallics as well as of a ternary ψ phase was revealed. Reactions between the ternary phase and the binary phases as well as between the Ce24Co11 and the Co7Mo6 intermetallics were observed. Figure 1; tables 2; references 9, 3 Russian, 1 Japanese, 5 Western.

Study of Titanium-Sponge Defects After Prolonged Storage

917D0083A Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 3, Apr 90 pp 67-73

[Article by V.A. Liskovich, V.M. Skrypnyuk, A.V. Berezhko, A.A. Dzhandubayev, and S.N. Voleynik, All-Union Titanium Scientific-Research and Design Institute]

UDC 669.295.018.8

[Text] A study of elemental and phase composition of brown, yellow, and gray oxide- and MgCl2-containing defects observed on pieces of titanium sponge stored for four years in closed containers filled with argon, as well as of the effect of storage conditions on the formation of these defects, is reported. The study employed chemical, spectrometric, electron-microscopy, x-ray diffraction, metallographic, and crystallographic methods. Storage defects were found to contain less nitrogen than oxidation defects on freshly produced sponge and more chlorine than defect-free sponge. The iron, manganese, nickel, and cobalt contents (originating from the magnesiothermic sponge production process) of storage defects was found to be one or two orders of magnitude lower than those of defect-free sponge. Some specimens of brown defects on stored sponge were found to contain elevated quantities of metallic magnesium, hydrated magnesium chloride, hydrooxychlorides of magnesium and calcium, and titanium oxychloride. Magnesium, silicon, and chlorine were found in chloride storage defects. Colored oxide defects on stored sponge were found to be a solid solution of oxygen in titanium, whereas these defects on freshly produced sponge contain rutile and a variable-composition solid solution containing oxygen and nitrogen. Laboratory experiments show that storage of moist sponge in ventilated containers (which promotes the formation of a protective film) produces fewer defects than nonventilated storage in air or storage in argon. It was found that high-quality titanium ingots can be produced from sponge containing storage defects. Figures 3; tables 3; 3 Russian references.

Hardening of Blanking Dies by Ion-Plasma Titanium Nitride Coatings

907D0082A Moscow KUZNECHNO-SHTAMPOVOCHNOYE PROIZVODSTVO in Russian No 10, 1990 pp 15-18

[Article by candidates of technical sciences G.S. Fuks-Rabinovich, A.N. Kuznetsov, K.S. Lenik, A.A. Katsura, and G.K. Dosbayeva and E.G. Samokha]

UDC 621.961.2.073.002.237

[Abstract] The wear of blanking dies coated with titanium nitride by condensation and ion bombardment was studied by measuring the fin height on finished blanks and the gap change between the working parts of the dies. The measurements were correlated with coating composition and hardness. It was found that fatigue spalling of the coatings is the chief cause of wear and that the wear can be minimized by combining high coating hardness with high adhesion to the steel substrate. Such a combination is achieved by using a nitrogen pressure in the coating chamber that results in a three-phase coating consisting of TiN, α-Ti, and TiN2, in which α-Ti ensures a strong metallic bond with the steel substrate. It is shown that sliding friction tests can be used to reliably predict the coating wear. Figures 4; tables 2; 3 Russian references.

Diffusion Welding of Hollow Thickwall Products by Isostatic Pressure

917D0031B Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 3-4

[Article by M. V. Gubinskiy, R. G. Kheyfets, G. I. Sinitsa, Dnepropetrovsk Metallurgical Institute]

UDC 621.791.4:539.378.3

[Abstract] The possibility was studied of cladding nuclear reactor parts such as thickwall sleeves by diffusion welding by means of isostatic pressure in an inert gas at up to 15 MPa. Studies were performed on two-layer stubs of 22K steel 12.5 mm thick clad on the inside with 08Kh18N10T steel (8 mm). The 300 mm stubs were 85 mm in diameter. After degreasing, the specimens were assembled by pressing the liquid-nitrogen-cooled inner layer into the outer layer, the ends were sealed by welding using an electrode of corrosion-resistant steel. Isostatic pressure welding was performed at 1373-1473 K with argon pressure 10-12 MPa, plus the additional pressure caused by the difference in thermal expansion of the layers. The strength of the joint produced was 310-330 MPa. Figures 4; References 3: Russian.

Mechanical Properties of Butt-Welded Joints of Deformed Aluminum Alloys

917D0031C Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 8-10

[Article by V. I. Ryazantsev, V. V. Ovchinnikov, V. V. Grinin]

UDC 621.791.052:620.17

[Abstract] A study is made of the influence of various process factors such as arc-welding method, type of welding wire, welding conditions, flux, shape of slot in liner and seam shape, as well as type of semifinished product on the static and cyclical properties of welded joints of deformed aluminum alloys AMg6, 1201, 1570, M40-1, as well as Al-Mg-Li and Al-Cu-Li alloys. The joints were produced by free surface continuous arc with nonmoving tungsten electrode with lateral feed of welding wire; by pulsating arc with powerful superimposed short current pulses; by pulsed arc; by pulsating arc; by rotating electrode with axial feed of welding wire; by plasma arc; and by arc with electromagnetic rotation. The static strength of the joints depended little on the method and conditions of welding and type of welding wire used. The type of semifinished product had a decisive influence on the static strength. The plastic properties of welded joints are largely determined by the welding method, type of welding wire and type of semifinished product. The best properties are achieved by pulse arc welding. The cyclical strength of the joints was decisively determined by the shape of the seam and type of semifinished product, the influence of the other factors being insignificant. For welded structures operating under stresses of 210-240 MPa or less with relatively small numbers of cycles, alloy 01570 is superior. The seam shape can be optimized by removing the melted material or, with flux welding, by the use of a special insert with a shaping slot. References 3: Russian.

Structure and Mechanical Properties of Welded Joints of Titanium With Zirconium Alloys

917D0031D Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 10-13

[Article by L. I. Adeyeva, A. B. Goncharov, V. F. Grabin, K. G. Grigorenko, T. V. Kayda, M. M. Nerodenko, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC 621.791.754'.291:[669.295+669.297]

[Abstract] A study is made of the influence of welding conditions and heat-treatment modes on the structure and mechanical properties of welded joints in VT1 titanium with zirconium alloys N-1 (Zr+1% Nb) and N-2.5 (Zr+2.5% Nb). Plates measuring 50x200x2 mm were automatically argon-arc welded using a nonconsumable electrode with jet protection of the welded zone and the cooling portion of the seam at 0.28 and 1.12 cm/s, 115 and 230 A, 11 and 12 V. The specimens were heat treated in a vacuum at 770 K and 1270 K, two hours, cooled with the furnace. The residual gas pressure in the furnace was not over 0.2×10^{-2} Pa. It was found that the electrode must be shifted 1.5-2 mm in the direction of the zirconium and the process performed at not over 0.3 cm/s to assure satisfactory quality. The seam metal is hardened during the welding process, greatly reducing ductility and toughness. This can be avoided by heat treating the welded joints at 1270 K with subsequent slow cooling with the furnace. The maximum relative elongation in this case is 14.5-15%, impact toughness 90-102 J/cm^2. Figures 8; References 3: Russian.

Corrosion Resistance of Welded Seams in Austenite-Ferrite Steels in Alkaline Media

917D0031E Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 15-16

[Article by A. G. Aleksandrov, Yu. N. Savonov, Zaporozhye Machine-Building Institute imeni V. Ya. Chubar]

UDC 621.791.052:620.193.2:669.15.018.8

[Abstract] The residual delta ferrite intended to reduce hot-crack formation in austenitic chrome-nickel steels can reduce the corrosion resistance of the seam metal. This article studies the corrosion resistance of welded joints in these steels in alkaline media. Specimens were made of 12Kh18N10T steel and multilayer surfaced pieces. Welding and surfacing were performed by type E-10Kh18N10G2B electrodes plus experimental electrodes containing chromium, nickel and manganese in a coating. The corrosion resistance of the specimens was evaluated by the degree of mass loss following 144 hours in 30-55% NaOH at the boiling point. The tests showed that seam metal with austenite structure had greater

corrosion resistance than austenite-ferrite surfaced metals. The failure of austenite-ferrite seams in alkaline media occurs by structurally selective corrosion with preferential dissolution of the delta ferrite. The corrosion rate of the surfaced metal was found to decrease with increasing content of chromium and nickel. Nickel helps to passivate the metal in alkaline media. Figures 2; References 10: 3 Russian, 7 Western.

Burner With Expanded Functional Capabilities for Vacuum Arc Welding

917D0031F Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 29-30

[Article by S. A. Karnaukhov, O. V. Kreydenko, V. M. Yampolskiy, Moscow, Higher Technical School imeni N. E. Bauman]

UDC 621.791.75.034

[Abstract] A new vacuum arc welding burner is needed, not requiring forced water cooling. This article presents a calculation of the operating conditions of such a prospective burner, indicating that the most heat-sensitive element, the insulator, could be made coolest by fabricating it of a material with low heat conductivity. The use of such a material, perhaps type 18-10 corrosion-resistant steel or titanium, would allow the temperature of this element to be reduced, supporting long-term operation of the burner without forced cooling. Production of an actual burner of this type is not reported and the only diagram presented is of the experimental installation for determination of heat liberation, which includes a water-cooling system. Figures 3.

Transportable Device for Welding Longitudinal Joints in Shells

917D0031G Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 30

[Article by V. V. Kalyuzhnyy, Voroshilovgradskiy Machine-Building Institute]

UDC 621.791.75.03(088.8)

[Abstract] A compact device is described, providing for unidirectional welding of longitudinal joints in shells with reverse seam formation under unsteady conditions. The device has been described in USSR author's certificate number 1201097, is reported to be reliable, with low cost and mass, suitable for use in the manufacture of shells as individual units rather than in long-run production. In the device, two slotted uprights support a flux bath, the height of which is adjusted by a cam unit, so that the meniscus of the flux rises to contact the joint, which is welded by manual or automatic means. The device is simple in design and suitable for welding of joints of various lengths.

Diffusion Welding of New TiC-NiTi Hard Alloy With Steel

917D0031H Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 32-33

[Article by A. G. Melnikov, S. N. Kulkov]

UDC 621.791.4.539.378.3

[Abstract] The purpose of this work was to produce a good quality diffusion joint between a TiC-NiTi hard alloy and type 45 steel. This requires an element which has good diffusion in both metals and produces no intermediate phases. Copper is used for this purpose. Diffusion welding was performed in a vacuum chamber at 0.01 Pa with induction heating of the specimens. A pneumatic lever mechanism was used to apply pressure to the parts, the surfaces of which had been ground and washed in gasoline and alcohol. The results were superior to those produced with a nickel intermediate layer, yielding a high-quality welded joint, the mechanical properties of which are close to those of the hard alloy. Figures 2.

Argon-Arc Welding of Lap and Tee Joints in Aluminum Alloys

917D0032A Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 2-4

[Article by M. d. Mamon, "Kompozit" Scientific-Production Association, O. M. Novikov, Scientific Research Institute of Machine-Building Technology]

UDC 621.791.754'29:669.71

[Abstract] A study is made of the formation of lap and tee joints, conditions of formation of oxide film inclusions and cold welds in the metal of angle joints and methods assuring the production of joints with good penetration of the root when welding aluminum alloys in protective gases by a tungsten electrode. The work was performed on 300×100 mm plates of AMg6 and 1201 alloy 2-12 mm thick and special small specimens of AMg6 alloy with circular lap joints. It is found that the appearance of oxide film inclusions in the joints results primarily from oxidation of the contact points of the end of the welding wire protected from the arc or flow of welding bath metal and the unmelted end surface of the edge of the upper part, plus lifting of surface oxide films by the welding bath from contacting horizontal part edge surfaces. Cold welds and oxide film inclusions in the root of the seam can be prevented by performing tungsten-electrode welding under inert gases in two or more passes: the first without a welding wire or with a small wire to produce a concave seam shape, with the use of cleansing flux; the second or other passes with wire to produce the required seam shape. Figures 2; References 2: Russian.

Friction Welding of Dissimilar Materials with Pulsed High-Pressure Forging

917D0032B Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 4-6

[Article by E. S. Karakozov, "Remdetal" National Scientific-Production Association, V. I. Yegorov, "ANITIM" Scientific-Production Association, Barnaul, V. I. Dyachenko, Ye. T. Puteyev, "MTZ" Production Association, Minsk]

UDC 621.791.14.01

[Abstract] Experiments are used to confirm that carbide lines do influence the strength of a welded joint of high-speed steel with structural steel, primarily where the process of final heat treatment of the product is not properly performed, specifically when the joint is immersed in melted salt during heating and hardening. This is explained by the fact that the hard and brittle phase inclusions serve as crack-formation centers. The solid solution near the carbide accumulations is also more alloyed, causing significant structural and chemical heterogeneity. Several models of machines which have been developed for friction welding with pulsed forging are briefly described and partially diagramed. The method of friction welding during pulsed high-pressure forging produces better quality joints between dissimilar materials which cannot be welded by traditional methods, such as ZhSL-750 high-temperature alloy and 40G steel. The method increases joint quality when welding dissimilar materials without the use of special arbors. Figures 3; References 7: Russian.

Embrittlement of Welded Joints in Steels Used in Cryogenic Equipment Upon Reheating and Deformation

917D0032C Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 9-11

[Article by P. S. Ivchenko, Dneprodzerzhinsk Industrial Institute imeni M. I. Arsenichev, V. Ye. Lazko, I. Ye. Labzina, T. L. Maksimovich, "VIAM" Scientific-Production Association]

UDC 621.791.052:669.14.018.8

[Abstract] An estimate is presented of the tendency of welded joints in various classes of cryogenic steels toward embrittlement in the process of heating and deformation involved in the manufacture of structures of the steels studied, which include austenitic 08Kh18N10T, austenitic-martensitic 07Kh16N6, martensitic 03Kh12N10MT and martensite-aging 00N14Kh5M3TYu, 03Kh9N9K5M3. A thermal cycle was used which imitated heating of the heat-affected zone between 20 and 1100°C upon automatic or manual arc welding with a running energy of 21.6 kJ/m. Along with the base metal, the seam metal produced by argon-arc welding with a nonconsumable electrode was tested in the state after complete or partial (tempering or aging) heat treatment. The changes occurring in the seam metal upon multiple-pass welding or welding repair of defects were simulated. The results of the testing indicated a monotonic decrease in strength of the base metal and seam metal with increasing test temperature. Comparative testing indicated superiority of the austenitic-martensitic steel 07Kh16N6, which was insensitive to embrittlement during the heat and deformation cycle of welding. Similar results were produced upon simulation of the heat-affected zone for multiple-pass welding. Exceptions included welded seams containing δ-ferrite in their structure, for which the temperature interval of embrittlement was 600-900°C as opposed to the 200-400°C for martensite and martensite-aging steels and 600-800°C for austenite steels, while the degree of loss of ductility was half as great. The formation of cracks in welded joints of cryogenic steels can be prevented by limiting the time they spend in the brittleness temperature intervals, and by avoiding straightening in this temperature range. Heating and deformation in the brittleness interval did not influence the properties of the joints when they are chilled. Figures 3; References 7: Russian.

Electrolysis-Water Generator Control and Protection System for Welding and Soldering of Products

917D0032D Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 13-14

[Article by I. V. Varlamov, N. A. Feoktistov, Moscow Institute of Technology]

UDC 621.791.945.03

[Abstract] Existing systems for powering and controlling electrolysis-water generators assure stability of operation but do not provide protection against excessive heating of the electrolyzer and pressure in the gas system, or against failures of individual elements and modules. This article studies a control and protective system based on measurement of pressure and temperature which does not have these shortcomings. A block diagram and photograph of the "Agat-M" device for soldering and welding of small domestic and jewelry products are presented. The authors institute provides a set of documentation for manufacture of the device upon request. Figures 2.

Structure and Process Design of Welded Joints for Thin Shells of High-Strength Materials

917D0032E Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 23-24

[Article by V. V. Yerofeyev, M. V. Shakhmatov, A. A. Raspopov, Chelyabinsh Polytechnical Institute, V. I. Mikhaylov, Central Scientific Research Institute TsNIIKM "Prometey," Leningrad]

UDC 621.791.013.5

[Abstract] The design of the structure and manufacturing process of welded shells made of high-strength steels and

alloys must consider two aspects: the variation in maximum load in the stage of loss of stability of plastic flow with the relationship of applied stresses in the wall of the shell, and, considering the specifics of the process of welding of high-strength steel and alloy structures, the inherent mechanical heterogeneity of these structures. Equal strength of welded joints with the base metal can be achieved by optimizing the dimensions of a soft butt well, considering the shape of the shell and the loads to which it is exposed in addition to the properties of the metal. A diagram is presented for determination of the ranges of permissible values of relative dimensions of a soft interlayer, allowing the assigned shell and welded joint parameters and the characteristics of the base metal to be used to determine the optimal dimensions of a soft butt joint. Figure 1; References 7: Russian.

Software System for Graphic Modeling of Welded Structures

917D0032F Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 38-39

[Article by S. V. Medvedev, T. V. Shestakova, G. G. Ivanets, G. Ye. Yurkoyt, Belorussian Republic Scientific-Production Association "Kompleks"]

UDC 621.791.052:681.5.015

[Abstract] A software system has been developed for graphic modeling of welded structures, designed to run on ARM2.01 standard configuration systems under OS RV version 3.0 or higher. The structure of the software system is diagrammed and samples of the assembly of graphics images with hidden-line removal are presented. The required input is a coded numeric description of the elements in a welded structure. A sample is presented. Preliminary drawings can be produced in half or three fourths the time required by traditional methods. Figures 3; References 2: Russian.

Industrial Use of Lasers in Pipe Welding

917D0103A Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 2-3

[Article by V. A. Panchev, V. A. Plekin, P. Ye. Gening, G. I. Khaustov, Yu. N. Bobylev, Ye. M. Krichevskiy]

UDC 621.791.72:621.375.826

[Abstract] In 1990, the "Razvitiye" Scientific Application Center and the "Sovinterluch" Joint Soviet-Bulgarian Enterprise introduced the method of laser welding on a pipe-welding machine at the Moscow Pipe Plant. A "Khebr-2.5" CO_2 was installed on a "20-76" machine. A three-reflector focusing lens developed at the Kazan affiliate of "Sovinterluch" was used to weld pipes of 08Kh18N10T steel with 1.5 mm wall thickness and 38 mm pipe diameter. No other modifications to the usual pipe production process were made. The welding process is illustrated photographically and welded seam cross sections are shown. A combined method of laser-arc welding has also been used, with the laser beam stabilizing the anode spot of the welding arc and increasing its effectiveness while the arc, by heating the metal, increases the absorption of laser radiation. This technology was tested on the same installation at the Moscow Pipe Plant, yielding superior seam formation and reducing the requirement for edge preparation. Figures 3; References 4: 2 Russian, 2 Western.

Increasing Speed of Laser Cutting of Metals by Plasma Heating

917D0103B Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 3-5

[Article by A. P. Khaloschin, Yu. V. Kurochkin, A. M. Lyubchenko, A. A. Zverev, Moscow Motor Vehicle Manufacturing Institute (ZIL Higher Technical School)]

UDC 621.791.947.72:621.375.826

[Abstract] One possible means of increasing the efficiency of laser cutting is to input additional energy to the work zone. This article discusses the results of experimental studies of laser-plasma cutting of metals, and the influence of the most important cutting mode parameters on cutting of Kh18N10T steel plates up to 2 mm thick and tungsten 0.5 mm thick. It was found that the additional energy of the plasma arc increased the cutting speed by a factor of two, being particularly effective for thin steel sheets (about 1 mm thick). The use of the plasma arc is most effective with a ratio of plasma arc to laser power of not over 3:1. Studies were performed on an installation with a 200 W laser operating at 1.06 μm and a special plasmatron with an electrical power of about 1 kW. Two systems were used to vary the position of the laser and plasmatron, and in the better of which the laser and the plasmatron acted on opposite sides of the metal plate being cut. Figures 4; References 5: 3 Russian, 2 Western.

Regulation of Surfaced Metal Quality by Changing Plate Electrode Shape

917D0103C Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 5-7

[Article by V. I. Shchetinina, S. S. Samotugin, A. N. Serenko, O. I. Novokhatskaya, K. K. Stepnov, N. G. Zavarika, B. B. Sologub, Maripole Metallurgical Institute, V. Yu. Poludnyak, V. G. Bendrik, Ye. I. Litvinenko, Maripole Metallurgical Combined imeni Ilich]

UDC 621.791.92.052:539.4

[Abstract] Five-layer surfacing was performed on plates measuring 30x300x400 mm using a wire 4 mm in diameter, a strip measuring 0.5x45 mm in the longitudinal and perpendicular directions, and a combined electrode consisting of a wire and a U-shaped strip. Surfacing was performed under ZhSN-5 ceramic flux. The electrode shape and running energy were found to have a significant influence on the movement of the arc, the thermal cycles and the crystallization rate. The shape

of the electrode and running energy also influenced the crack resistance of the surfaced metal. The structure of the metal produced with the combined electrode at low running energy has the best impact toughness and strength. These conditions yield the least microscopic distortion of the crystalline lattice and microstresses, low dislocation density, a finely dispersed and homogeneous structure of the surface metal with small temper zone. Figures 6; References 5: Russian.

Properties of Welded Joints in 10KhSND Thick Sheet Steel Made by Various Welding Methods

917D0103D Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 8-109

[Article by A. I. Patrikeyev, A. N. Serenko, V. A. Shaferovskiy, A. L. Druzhinin, A. I. Savchenko, I. G. Leshkovtseva]

UDC 621.791..052:630.18:669.15-194

[Abstract] To provide a comparative evaluation of the properties and structure of joints of 10KhSND thick sheet steel specimens were welded under flux by three methods: with programming of the mode parameters, mechanized multipass welding and a mechanized method with a constant-power arc in one pass. Programmed welding was found to yield the most even distribution of manganese. The cyclical thermal effect of the programmed welding formed more equilibrium structures both in the heat-affected zone and in the seam metal. Impact toughness increased significantly due to the fine-grain structure, more uniform distribution of alloying elements and microhardness through the cross section of the welded joint in comparison to the other methods of arc welding under flux. Figures 4; References 8: Russian.

System for Gas-Thermal Atomization of Protective and Hardening Coatings

917D0103E Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 25-26

[Article by P. A. Topolyanskiy, Leningrad "Electrosila" Production and Experimental Association imeni S. M. Kirov]

UDC 621.793.72

[Abstract] An equipment system has been developed for gas-thermal atomization, allowing objective selection of the optimal method for application of protective coatings from the standpoint of coating quality, good usage properties, economy and ecologic characteristics. The system includes: a power supply, plasmatrons, detonation guns and supporting components, horizontal manipulator for the plasmatrons and gun, manipulator for holding, rotation and vertical movement of parts to be coated, remote control panel, modules for independent dosing of outer materials and independent cooling, gas supply and ventilation systems. The technical specifications of the system are presented. Introduction of the system has increased the quality, reliability and durability of electrical machine parts by detonation atomization of wear-resistant and antifriction coatings based on aluminum oxide onto the end seals of large electrical machines, automatic plasma atomization of fretting-resistant coatings based on aluminum alloy in an inert gas onto the brush wedges of turbine generators, manual plasma atomization of cavitation-resistant coatings based on nickel-titanium on electric machine rotor poles, and air-plasma atomization of errosion-resistant coatings based on stellite on the fan blades of turbine generators. Figures 2; References 3: Russian.

Programming Module With Power Supply for Arc Welding

917D0103F Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 27-28

[Article by N. G. Sinelnikov, M. D. Ivanov, A. I. Vanin, Moscow Aviation Institute imeni S. Ordzhonikidze]

UDC 621.791.75.037

[Abstract] A programming module has been developed for joint operation with modern semiconductor arc power supplies. One important feature of the module is the program control of various welding cycles, provided for convenient operation and ease of use. The memory capacity of the device is sufficient to store program cycles for welding by infusible electrodes in inert gases, plasma welding, welding with consumable electrons in protective gases and under flux. Memory capacity can be expanded as needed. The module consists of a processor, synchronized by the 50 Hz line power and designed to process and output control signals, a decoupling module which provides galvanic isolation of the processor from the other units, a logic module which translates instructions in ROM and PROM to signals controlling the processor, an LED indicator showing the operating phase cycle, a power module controller and various peripheral devices. The programmer support program control of the static and dynamic parameters of an arc power supply, as well as other welding equipment. Figures 2; References 2: Russian.

Transducers for Adaptive Arc Welding Automatic Process Controller

917D0103G Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 29-30

[Article by S. B. Shakhanov, N. G. Myasnikov, V. M. Popkov, Leningrad Mechanical Institute imeni D. F. Ustinov]

UDC 621.791.75.03-75

[Abstract] The use of a control computer in an automatic welding process controller requires that the signals provided by sensors be in digital form, while the results of measurement be presented in a form which is easy to read. A device is illustrated which includes photographic sensor which follow the edges of pieces of metal to be

welded together and a unit which converts the measurement result to digital form for transmission to the control computer. The device combines instruments for measuring the width of the gap between the welded edges and the vertical positions of the edges. Use of this unit reduces the labor consumption of welding of units of thin sheets of high-strength steel by reducing the demands for accuracy of reassembly of the units before welding. Figure 1.

Comparative Evaluation of Residual Stresses in 01570 Alloy Welded Joints

917D0103H Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 90 pp 35-36

[Article by N. M. Bukhanova, T. N. Osokina, V. M. Arbuzov, Scientific-Production Association imeni S. A. Lavochkin]

UDC 621.791.754'29-52:052.539.4.014

[Abstract] The Institute of Mechanics Problems, USSR Academy of Sciences has developed a method for determining residual stresses by laser interferrometry, involving drilling 1.5-2 mm diameter apertures less than 2 mm deep on the surface of a specimen. Interferograms are recorded by a double exposure method, with interferograms recorded before and after the small holes were drill, causing deformation of the area adjacent to each aperture due to redistribution of residual stresses. The results obtained agree well with electrode tensometry results. The studies indicate that heating of 01570 alloy to 350-370°C for one hour relieves residual stresses to the 10-20 MPa level. Figures 2; References 5: Russian.

Structure and Mechanical Properties of Welded Joints in Zirconium-1%

917D0104A Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 11-14

[Article by A. B. Goncharov, M. M. Nerodenko, L. I. Adeyeva, L. M. Tkachenko, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC [621.791.754'291.052:669.296'293.5]:620.18

[Abstract] A study is made of the influence of welding conditions and subsequent heat treatment on the mechanical properties and structure of welded joints in the alloy Zr-1% Nb. Arc welding was performed on specimens measuring 300x60x2 mm in helium using infusible tungsten electrodes at 80 and 180 A, 0.28 and 1.68 cm/s. Heat treatment was performed in a vacuum (0.2×10^{-2}Pa) at 850, 1050 and 1270 K, 2 hours. Specimens were cooled after heat treatment together with the furnace. It was found that Zr+1%Nb is insensitive to welding conditions in the range studied. The metal of the welded joints is equal in strength to that of the base metal, has high plasticity and good impact toughness. The optimal combination of strength and plasticity characteristics in welded joints is obtained by heat treatment in the α area at 850 K, 2 hours. This heat treatment has no influence on the structure and mechanical properties of the base metal. Annealing in the β area significantly reduces the structural heterogeneity in the seam, heat-affected zone and base metal. Figures 4; References 2: Russian.

Structural Transformations in Joints of Hardened Steels Upon Argon-Arc Welding With Thermal Cycling

917D0104B Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 28-31

[Article by V. A. Dovzzhenko, M. M. Savitskiy, A. F. Lupan, V. N. Lipodayev, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC [621.791.754'293.052:669.15-194.2]:620.18

[Abstract] A study is made of the influence of thermal cycling during multiple-pass argon-arc welding of 40Kh and 30KhGSN2MA steels on welded joint structure formation. The possibility is also studied of using thermal cycling during welding without preheating and subsequent heat treatment. Studies are performed on steel specimens 25-40 mm thick, with multipass welding performed with an infusible electrode in a narrow gap with Sv-10Kh5M and Sv-20Kh4GMA welding wire. Welding is performed with two or three cycles, maximum reheating temperature 730-1100°C and temperature to which the metal is cooled before each cycle 20-400°C, heating and cooling rates 1-25°C in the 500-600°C interval. Results are determined on the basis of metallographic analysis of the structure of the welded joints, mechanical properties and results of delayed strength testing. It is found that thermal cycling can control the type and relationship of structural components in the heat-affected zone and facilitate the formation of equiaxial structures in the welded joints. Multipass argon-arc welding of the steels studied allows the production of good-quality joints not requiring subsequent heat treatment. Figures 3; References 13: Russian.

Welding of High-Strength Steels with Yield Point Over 800 MPa Without Preheating or Heat Treatment

917D0104C Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 38-40

[Article by Yu. N. Gotalskiy, V. V. Snisar, E. L. Demchenko, V. N. Lipodayev, O. I. Yankina, G. N. Kachanov, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, L. V. Grishchenko, "Promethus" Central Scientific Research Institute]

UDC 621.791.75.053:669.14.018.295

[Abstract] A new technology has recently been suggested for welding of high-strength hardening steels, involving the use of welding materials which assure the production of seam metal with austenite-martensite structure. Decomposition of austenite in the seam occurs at under 200°C, forming products which given the seam metal

high strength characteristics along with good plasticity and toughness. This process allows these steels to be welded without reheating or subsequent heat treatment, producing welded joints of strength equal to the base metal. This article studies the use of this process by manual arc welding using new type ANVP-80 electrodes. The rod used is EK-17VI wire (TU 14-1-3036-80) with a new type of coating, the composition of which can be obtained from the Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences on request. These electrodes support welding in dc with reverse polarity and guarantee good seam quality in all positions. Hydrogen content in the seam metal is not over 3 cm^3/100 g. Figures 2; References 8: Russian.

Welding of Thick Sheet Structures of Low Alloy High Strength Steel

917D0104D Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 41-45

[Article by L. I. Mikhoduy, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, A. K. Gonchar, Kiev Polytechnical Institute]

UDC 621.791.75.052:669.15-194.2-413

[Abstract] An estimate is produced of the influence of preliminary and post-welding heating, selection of optimal wire chemical composition, and furnace tempering of a welded joint on the level of residual stresses in the metal of multilayer seams in thick-sheet structures of low-alloy high-strength steels with yield point 590-690 MPa. Residual stresses were determined in multilayer seams of butt joints in plates of 14Kh2GMR steel measuring 500 x 300 mm, 30, 40, 60, 70, 100 and 120 mm thick. Automatic multilayer welding was performed under AN-17M flux using Sv-08KhN2GMYu wire 4 mm in diameter, welding current 600 A, voltage 37 V, speed 21.5 m/hr, and also by mechanized welding in carbon dioxide with PP-AN54 wire 2.2 mm in diameter, 350 A, 33 V and Sv-G8A2S wire 1.6 mm in diameter, 250 A, 30 V. The root of the multilayer seam was found to undergo bidirectional deformation as each next pass was welded, reducing the deformation capacity of the metal and possibly causing cracks in combination with the distribution of residual stresses typical of multilayer welding. Cracks can be prevented by the use of Sv-08G2S wire. Heating after welding did not significantly change residual stresses. However, it did decrease the content of hydrogen in the seam metal. Figures 7; References 14: Russian.

Welding of Cold-Resistant Steels With 6 and 9% Nickel in Position for Installation During Construction of Reservoirs of Up to 10,000 m^3

917D0104E Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 48-52

[Article by K. A. Yushchenko, G. G. Monko, T. M. Starushchenko, V. A. Pestov, L. S. Zakharov, A. M. Solokha, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, A. K. Meshkov, B. A. Levitskiy, A. G. Ivanov, "UkrTsentrostalkonstruktsiya" Trust, Kiev]

UDC 621.791.75.002:669.15'24.018.41:621.642.2/.3

[Abstract] The need for large reservoirs for liquefied natural gas and other cold products has generated a need for methods for welding steels containing 6 and 9% nickel with economical nickel alloy welding materials by processes suitable for use in the construction and installation of isothermal reservoirs of large size. Experiments were performed on metal 10 and 14 mm thick from commercial batches of 0N6 and 0N9 steel. Welding was performed with ChS-39 (Sv-03Kh19N15G6M2AV2) wire. A search was made for a slag system suitable for use as a flux to minimize oxidation of the alloying elements, avoid reducing silicon and yield joints with low contents of oxygen, sulfur and phosphorus. Highly basic ANK-60 ceramic flux based on CaF_2-CaO-MgO-FeO-SiO_2 was found to be effective when used under conditions such that the participation of the base metal in formation of the seam metal was not over 20%. ANV-40 and ANV-41 welding electrodes were developed for the process, which was used to assemble two 10,000 M^3 capacity reservoirs, yielding a significant economic effect. Figures 3.

Welding Arc as Information Source for 'Sensitization' of RM01 Industrial Robots

917D0104I Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 69-72

[Article by V. A. Timchenko, G. A. Tsybulkin, O. V. Vlasov, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC 621.791.754.03:007.52

[Abstract] In order to give the RM01 robot adaptive properties sufficient for correction of the trajectory of movement of a welding tool, information on the variation of welding arc parameters over a fixed time interval can be used to determine the displacement of the joint line. The information parameter used can be the welding current, arc voltage, number or duration of short circuits per unit time. This article discusses a new approach involving programming the trajectory of movement of the robot manipulator by assigning a sequence of positions for the manipulator at both nodal points of its trajectory and at intermediate points, with the intermediate points assigned in the local coordinate systems with special orientation based on origins at the nodal points. The coordinates of each subsequent intermediate point are adjusted based on information obtained on the welding parameter. This approach to trajectory adjustment has been found to be quite effective, allowing simple correction of the preprogrammed intermediate points. Experimental results have confirmed the efficiency of the automatic correction system and the possibility in practice of "sensitizing" the RM01 robot by employing the parameters of the welding arc as an

information source to determine the necessary correction to the intermediate points. Figures 2; References 10: 9 Russian, 1 Western.

Arc Welding of Low-Alloy Steels With Forced Seam Formation and Great Electrode Tip Extension

917D0104F Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 53-57

[Article by A. N. Pashchin, S. M. Dudko, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC [621.791.75.053:669.15-194.2].002

[Abstract] A study is made of the possibility of reducing running energy consumption and increasing productivity of mechanized arc welding of vertical seams with forced seam formation by increasing the electrode projection using self-protecting powder wire. An insulating guide jacket was used to prevent wandering of the electrode tip. The feed mechanism was redesigned to allow a maximum electrode feed rate of 900 m/hr. The increased electrode projection requires an increase in power supply idle voltage. The decrease in voltage in the arc caused by the increased projection also decreases welding current, requiring an increase in electrode wire feed rate. The melting coefficient and productivity of the process increase linearly with increasing projection. The range of operating currents over which the process is stable decreases with increasing electrode projection. Increasing electrode projection allows the heat applied to the metal to be varied over broad limits. A nomogram is presented for selection of edge finish shape and welding conditions for several types of steels to assure the required impact toughness. Figure 5; References 4: Russian.

Welding of High-Manganese Steels by Light Beam

917D0031A Moscow SVAROCHNOYE PROIZVODSTVO in Russian Aug 90 pp 2-3

[Article by M. I. Oparin, F. A. Frolov, A. N. Svobodov, V. S. Mamayev, N. S. Pronin, Moscow Institute of Aviation Technology imeni K. E. Tsiolkovskiy]

UDC 621.791.72.77

[Abstract] A promising source of energy for welding of steels and iron-manganese-based alloys is the focused light beam of xenon arc lamps. The comparatively lower heat flux density of light-beam welding (10^3-10^4 W/cm^2), low mechanical influence of the welded bath and absence of intensive bath mixing can reduce the heating of the liquid metal and minimize the loss of manganese. A comparative analysis of the results of light-beam and argon-arc welding with a tungsten electrode was performed for butt joints in plates measuring 200 x 100 x 4 mm. Light-beam welding was performed on experimental installation developed at the authors' institute. The light-beam welded seams contained no defects and had austenitic structure with minimum content of δ ferrite. The use of the focused light beam reduced the loss of manganese in the seam and achieved joints with greater density and ductility than argon-arc welding with a type ADSV-6 automatic welding machine. Figures 3; References 3: 2 Russian, 1 Western.

Welding Up Ends of Capillary Tubes With Infusible Electrode Without Filler Material

917D0104G Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 58-61

[Article by D. M. Pogrebiskiy, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC [621.791.7.037:532.66].002

[Abstract] Seam formation conditions are studied during welding up of the ends of capillary tubes by the argon-arc or microplasma method without the use of a filler material. The basic parameters of the welding process are the integral power, welding time and length of fused end of tube projecting from heat-transfer fitting. The welding process with no filler material is found to be effective for tubes in which the ratio of outside diameter to wall thickness is not over 10:1. Tubes with higher D/δ ratio, particularly with ratios over 20-30, should be welded using a plug or insert filler. The optimal projection of the tube end from the heat sink is approximately equal to the tube diameter, and is an important parameter of the process. To assure good seam quality its height should be no more than 2-2.5 times the tube wall thickness, the outside diameter no more than 20% greater than that of the tube. Figures 4; References 5: Russian.

Flattening and Welding Up of Thermoplastic Tube Ends

917D0104H Kiev AVTOMATICHESKAYA SVARKA in Russian No 10, Oct 90 pp 62-64

[Article by V. P. Tarnogrodskiy, Ye. Yu. Ponomareyva, Yu. A. Bolduy, M. G. Menzheres, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, A. P. Sanin, Sevgiprorybflot]

UDC 621.791:678.029.435:621.643.29

[Abstract] A method has been developed for sealing the ends of thermoplastic tubes for nonpressurized structures by press welding the end of the tube. The method involves heating the end of the tube to a length at least equal to the outside diameter, flattening and welding in a press. The method allows the ends of tubes of various diameters made of polyethylene and polypropylene to be sealed. A photograph is presented of the installation for sealing tube end, and another of a flattened and sealed tube end made using the device. Tensile testing indicated

that the strength of the joint formed is at least 70% of the strength of the base material. Figures 3; References 3: Russian.

Effective Modes of Resistance Welding of Electronic Part Contact Units in Mass Production

917D0035A Moscow SVAROCHNOYE PROIZVODSTVO in Russian Jul 90 pp 3-5

[Article by N. I. Ivanov, V. I. Stroyev, Kursk Polytechnical Institute]

UDC 621.791.762.1

[Abstract] In mass production, contact units are welded on highly productive automatic resistance welding machines in a cycle of compression with constant force and heating by a pulse of current. A resource-conserving technology of welding using a cycle with compression by a variable force on the electrodes and heating with a trapezoidal pulse of current has been developed which, however, suffers from difficulty of selecting the great variety of parameters available for the specific welding job. The solution of this problem is simplified by the use of a set of curves illustrating operating modes constructed by the use of a statistical model of the welding process, describing the interrelationship of mode parameters with joint quality criteria. Equations are presented, describing the statistical model of the process used to develop the curves. Figures 3; References 7: Russian.

Influence of Preparation and Heating Conditions of Welded Surfaces on Joint Formation Upon Diffusion Welding of Titanium Alloys

917D0035B Moscow SVAROCHNOYE PROIZVODSTVO in Russian Jul 90 pp 5-6

[Article by V. I. Grigoryevskiy, V. K. Akinin]

UDC 621.791.4:539.378.3:669.295

[Abstract] A study is presented of the influence of the conditions of heating welded surfaces after various methods of surface preparation on the formation of joints in diffusion welding of titanium alloys. The experiments utilized the titanium alloy OT4, which has an equiaxial fine-grained structure as delivered. Experiments were performed on specimens simulating microscopic projections in welded surfaces with cone tip angles of 150°. Specimens were welded in two stages of 30 minutes each, stage one involving application of external pressure 9.8 MPa at 293-1123 K, stage two involving annealing at 1198 K without external pressure to improve the mechanical properties of the joints. It is found that the greatest effect is achieved by identical preliminary oxidation of the interacting surfaces in the process of heating the specimens, while shot-impact processing can disperse preliminarily saturated films to dimensions comparable to those of the oxide-forming seeds. Figures 3; References 3: Russian.

Unstressed Soldering of Ceramic and Metal Parts

917D0035C Moscow SVAROCHNOYE PROIZVODSTVO in Russian Jul 90 pp 14-15

[Article by Yu. V. Naydich, B. D. Kostyuk, V. L. Poberezhnyuk]

UDC 621.791.3.016:666.3/7:621.81

[Abstract] A study is made of the possibility of producing an unstressed metal-ceramic solder joint by the use of a continuous lining material consisting of spiral cylindrical elements placed in contact with each other and joined either by means of a metal filament or a non-coking polymer binder. The material is produced by placing a set of helical spirals of identical length and diameter horizontally in a single layer so that they are pressed against each other over their entire length, then adding the binder. The article also studies the influence of the laying parameters, area of the solder joint and thickness of the solder layer on the strength of the joint between the ceramic and metal produced by this method. The method is found to produce unstressed solder joints between ceramic and metal, and was used to produce specimens of various types including lap joints with a lap area of 100 cm^2, conical-surface and combined joints with strengths of up to 20-25 MPa, operating temperature up to 973 K. Figures 5.

Independent Attachment for Welding Titanium

197D0035D Moscow SVAROCHNOYE PROIZVODSTVO in Russian Jul 90 pp 23-24

[Article by A. V. Granovskiy, N. A. Makarenko, K. V. Lesnyak, Kramatorsk Industrial Institute]

UDC 621.791.1/8+621.791.94]03:669.295

[Abstract] An attachment has been developed for dc welding machines. It is powered by the welding circuit, making it easier to use and allowing its use under manufacturing plant conditions with welding rectifiers and converters, or under field conditions with diesel or gasoline-powered welding units. A schematic diagram is presented and its operation is described. Figure 1.

Seam Formation in Welding of Fiber Composites

917D0027B Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 31-34

[Article by A. G. Kramarenko, B. M. Berezovskiy, Chelyabinsk Polytechnical Institute, V. R. Ryabov, I. S. Dykhno, I. V. Zvolinskiy, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC 621.791.75.053:669-419

[Abstract] A study is made of the specifics of formation of seams when welding with a seam insert and of means to optimize welding technology. The seams were produced by melting the part through its entire thickness in a single pass. A system of eight equations is presented to describe the shape of the surfaces of the seams thus

produced. The model can be used to determine the optimal conditions for the formation of such seams with both surfaces convex (no sagging or concave surfaces). Production of seams of the optimal size is difficult in aluminum alloys and composite materials with aluminum matrix in which the heat conductivity is high. Figures 6; References 2: Russian.

Specifics of Structure in Joint Zone of Corrosion-Resistant Bimetal Layers

917D0027A Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 28-31

[Article by B. I. Medovar, G. M. Grigornko, S. V. Krivosheya, G. A. Boyko, Ye. V. Tkachenko, A. V. Tayanovskaya, V. V. Statsenko, L. I. Markashov, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC
[621.791.4:621.771]:[669.14.018.29+669.14.018.8]:620.18

[Abstract] Various intermediate layers are used in corrosion-resistant bimetals manufactured by rolling and welding to prevent diffusion of carbon from the structural steel into the stainless steel. The authors studied a bimetal consisting of type St3 steel plus 12Kh18N10T steel with intermediate layers consisting of a 40 μm galvanic nickel coating on the stainless steel, 50 μm-thick foils of nickel-based alloy and 200 μm-thick nickel foil. Studies were performed on a scanning electron microscope and by transmission electron microscopy. Photographs illustrate the microstructure of the joint zone in bimetals with the various intermediate layers tested, with particular attention to the status of the boundary between layers and the presence of defects such as pores and inclusions. The studies showed that the most important factor in decreasing the bond strength is structural defects at the boundary between the interlayer and clading layer. The formation of common grains at the boundary between the stainless steel and nickel-based interlayer yields a bimetal with the best strength properties. Figures 2; References 4: Russian.

Formation of Transition Zone Structure in Steel-Aluminum Adapters by Butt Welding With Low-Pressure Arc

917D0027C Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 34-38

[Article by A. N. Muraveynik, V. R. Ryabov, I. Ya. Dzykovich, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, V. A. Veselov, V. A. Andrienko, "Kislorodmash" Scientific-Production Association, V. A. Sidyakin, Moscow Institute of Aviation Technology]

UDC
[621.791.44:621.3.014.31-984]:[669.14+669.71]:620.18

[Abstract] A study is presented of the formation of the structure of the transition zone in joints in 12Kh18N10T steel with AD1 aluminum and AMts alloy by butt welding with heating by a low-pressure arc. Pipes of the steel were butt welded with aluminum pipes, producing a continuous intermetallide layer 1.5-2 μm thick with the AD1 alloy, having microhardness 9400-9900 N/mm^2. Eutectic segregations were found on the grain boundaries in the aluminum, with somewhat more eutectic at the joint line. The microhardness of the metal in this area was 150-200 N/mm^2 greater than in the aluminum base metal. The formation of common grains indicates good-quality joining of the cast and deformed metals. Microscopic x-ray analysis of the transition zone indicated a high content of iron, nickel and somewhat higher chromium on the grain boundaries of the contact area of the aluminum, indicating diffusion of these elements. All specimens mechanically tested failed in the aluminum far from the joint. Welded specimens with AMts alloy usually failed at the seam or in the heat-affected zone on the aluminum side. This apparently results from diffusion of iron in the contact area, greatly reducing the solubility of maganese in aluminum by production of the phase $(MnFe)Al_6$, almost insoluble in aluminum. The short-term tensile strength of all welded joints was at least equal to the strength of the aluminum or AMts base metal in the annealed state. Figures 5; References 8: 6 Russian, 2 Western.

Formation of Joints in Dissimilar Metals by Condenser Welding

917D0027D Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 38-41

[Article by D. M. Kaleko, N. A. Chvertko, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC 621.791.762.052:620.18

[Abstract] The effective energy expended to heat welded parts in condenser welding is not great and is located in narrow zones adjacent to the joint, resulting in incomplete mutual dissolution of the welded metals and mutual diffusion. Condenser welding of thin wires usually forms joints in the plastic state. Good-quality joints between thin wires and plates require that the hardness of the wire be less than that of the plate. In a welded joint between copper and aluminum produced by this method there is a clear copper-aluminum interface with no visible mutual diffusion. In some cases inclusions of crystallized plate metal are seen in the wires when copper wire is welded to steel plates by condenser discharge. Condenser welding of pins 2-10 mm in diameter differs in that the welding current and arc discharge time are an order of magnitude greater. Welding of steel pins to aluminum alloy plates is particularly interesting, as is the welding of pseudoalloys produced by powder metallurgy with compact materials. The small volume of metal melted and its rapid crystallization mean that the quantity of intermetallic phase in joints made of metals with limited solubility is small and is located in a plastic

matrix, which has a favorable influence on the mechanical properties of the joints. Figures 6; References 4: Russian.

Wettability of Refractory Materials by Aluminum Melt in Arc Discharge

917D0027E Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 41-45

[Article by V. R. Ryabov, I. S. Dykhno, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, S. L. Dykhno, Kiev Production Association imeni Artem, G. F. Deyev, V. V. Karikh, Lipetsk Polytechnical Institute]

UDC 621.791.75.011:[669.018.45+669.71]

[Abstract] During welding of composite materials the possibility of welding by melting is largely determined by the wettability of the fibers with the melted metal. This article studies the wettability of niobium, zirconium, titanium, tungsten, boron, armco iron, St3, 45, U10 steels and cast iron by an aluminum melt under the influence of an arc discharge. Studies were performed by preheating the substrate to 933-953 K and determination of the contact wetting angle. The contact wetting angle in studies with carbon steels and cast iron was influenced by the substrate material. The growth rate and structure of the intermetallic phase zone depended largely on the composition and structure of the solid metal. When aluminum interacted with armco iron a diffusion layer was formed with deep projections into the steel, when St3 and type 45 steel were used the height of the projections decreased. In U10 steel a comparatively smooth diffusion layer was formed with small projections growing into the aluminum. The wettability of the aluminum was related to the content of carbon in the solid metal. Wetting of boron by aluminum was performed with contact times of not over 10 seconds, and the contact wetting angle dropped as in steel with increasing welding current. No oxygen-containing phases were found on the surfaces of the materials. Similar contact wetting angle variation with welding current and drop mass was discovered for niobium-aluminum and zirconium-niobium-aluminum. The change in contact wetting angle depends on the intensity of the physical-chemical reaction occurring at the phase interface. The interphase energy at the solid-melt interface makes a significant contribution to the surface energy of the process of wetting of solid substrates by aluminum melts. Values of the heats of formation of a number of aluminides are presented in a table. When metals contact an aluminum melt their wettability is largely determined by the oxide film on the surface of the aluminum melt. Wettability is therefore slightly improved when carbon is added to the metal and when titanium is used as the substrate. Figures 7; References 14: 13 Russian, 3 Western.

Planning of Mechanized Welding of Thickwall Nonstandard Spherical Reservoirs

917D0027F Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 46-49

[Article by O. N. Tishchenko, M. V. Volik, deceased, Trest No. 7, USSR Specialized Construction and Installation Ministry, A. I. Romanchenko, B. F. Lebedev, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC 621.791.75.002:621.642.1-413

[Abstract] The authors' organizations have developed and introduced a mechanized method of welding the meridional joints in shells with wall thicknesses of 25-34 mm on site without requiring that these large structures be rotated. This avoids the use of complex manipulators and allows the work to be performed by several automatic welders simultaneously. The new technology was based on the use of foreign experience, as well as domestic experience in the construction of spherical reservoirs with wall thickness 16-24 mm. The parts of the vessels were first held in place by U-shaped welded brackets, then welded into two passes by type A-1381U automatic welders designed at the Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences. Type PP-AN19N welding wire was used in the positions on the tops and sides, type PP-AN19S in the bottom position and vertical position. The diagrams of the welding process, which utilized water-cooled sliding external shapers, are presented. Mechanical testing showed that the properties of the welded joints met the requirements of state standard 26-291—87 for steel welded vessels and equipment. Figures 2; References 2: Russian.

Nonmetallic Inclusions in Joint Zone of Bimetallic Sheet Materials

917D0029A Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 36-40

[Article by G. A. Byalik, E. I. Tsivirko, V. I. Gontarenko, Zaporozhey Machine Building Institute, G. A. Boyko, a. g. Bogachenko, S V. Krivosheya, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences]

UDC [621.791.4:621.771.052:669.14-419.4]:539.219.1

[Abstract] A study is made of the microstructure of the joint zone between layers of a bimetallic specimen made by welding rolled goods. The base layer consists of type St3 steel, the cladding layer of 12Kh18N10T or 10Kh17N13M2T steel. Three processes were used: base and cladding layers joined by nickel galvanic interlayer 40 μm thick, nickel foil and foil made of a nickel-based alloy. Metallographic and x-ray spectral microanalysis was performed on sections which intersected the boundary between the base and cladding layers. Oxide inclusions accumulated at this boundary, and were largest for the nickel galvanic coating. The nonmetallic

phase contained significant quantities of silicon oxides. As the degree of deformation of the bimetallic sheet in hot rolling increased, the content of oxide inclusions significantly decreased. It is possible, by regulating process factors, to control the nature, content and distribution of nonmetallic inclusions in the bimetal, thus improving its physical and mechanical properties. Figures 6; References 4: Russian.

Formation and Structure of Electrometallization Coatings in Steel-Aluminum System

917D0029B Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 41-44

[Article by A. L. Borisova, B. G. Gubenko, V. A. Kostin, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, B. Ye. Glibovitskiy, Lvov Affiliate, "Soyuzenergoremont" Central Design Office, USSR Ministry of Power Engineering, S. G. Ostapchenko, Kiev State University imeni T. G. Shevchenko]

UDC 621.793.724:[669.141.24+669.71]:620.18

[Abstract] A study is made of the mechanism of formation and specifics of the structure of electrometallization coatings in the system 65G steel-aluminum. The external appearance, structure, phase and particle-size distribution of particles (products of simultaneous atomization of electrode wire made of 65G steel plus aluminum) trapped from the metallization jet were studied, as well as the structure and phase composition of the coatings which they produced by atomization using a three-jet electrometallizer designed by "Soyuzenergoremont" Design Bureau. All intermediate phases formed by the interaction of iron and aluminum were found both in the same and in different physical states. The coating was found to inherit the basic morphologic characteristics of the atomization products. Its structure is determined by the conditions of interaction of the particles with the base material and each other. The optimal combination of properties (moderate microhardness and good ductility) was achieved in coatings containing 10% aluminum. Figures 5; References 7: Russian.

Fatigue Resistance of Marine Engine Crankshafts With Casting Defects Corrected by Welding in Carbon Dioxide

917D0029C Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 56-58

[Article by T. Robakovsky, Ya. Chukhryy, Institute of Welding, Glivitse, Poland]

UDC 621.791.754'264:[621.824:621.746.019]

[Abstract] In Poland, crankshafts are manufactured of S36F killed steel made in a furnace with a basic lining. The chemical composition of the steel is, %: C not over 0.36, Mn not over 0.80, Si not over 0.45, P equal 0.04, S not over 0.04, Cu not over 0.30, Cr not over 0.30, Ni not over 0.40, Mo not over 0.15. Mechanical properties: yield point 270 MPa, ultimate strength 520 MPa, reduction in area 45%, impact toughness 49 J/cm^2. Local defects sometimes occur during casting of crankshafts. The Institute of Welding has developed a technology for correcting defects by welding of defective areas in carbon dioxide gas without subsequent heat treatment. Fatigue testing of specimens cut from crankshafts with welded artificial defects of various sizes and depths was undertaken. Artificial defects were produced by drilling. Fatigue cracks developed due to the influence of defects only in specimens with defects of the middle of three sizes tested, with diameter and depth 2 mm. Improperly repaired defects, in which the weld metal did not completely fill the defects, had reduced fatigue resistance. The defect repair process did not reduce the service life of the crankshafts. However, the proper repair process must be observed to assure good quality repair. Figures 4.

Breaking Up Ship Hulls With Directed Explosive Charge

917D0029D Kiev AVTOMATICHESKAYA SVARKA in Russian Jun 90 pp 73-74

[Article by A. Ya. Koroteyev, Yu. V. Grechka, V. I. Yermenko, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, Ye. A. Kobtsev, A. P. Kozlov, Sevastopol, V. N. Sudzilovskiy, "Yuzhvtorchermet" Production Association, Dnepropetrovsk]

UDC [621.791.72:621.373.826:669.686.5].002

[Abstract] Experiments were performed on the use of directed explosive charges to break up the hulls of abandoned ships into large parts suitable for subsequent transportation by water or road to shops for further reduction to standard dimensions to allow reuse of the metal. Experiments were performed on two ships of 31 and 250 t displacement, 21 and 40 m in length, 3.8 and 6 m beam. The ships were first drawn out onto the shore, the rudder and superstructure removed by setting off individual charges developed at the Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, then the hull was broken up by simultaneous explosion of special charges placed along the length of the hull. Photographs illustrate the effectiveness of the method. Figures 2; References 2: Russian.

Main Reserve: New Technologies

917D0118A Moscow METALLURG in Russian No 10, Oct 90 pp 32-34

[Article by G.G. Yefimenko, corresponding member, UkSSR Academy of Sciences]

[Abstract] Considering that industrial development of any country cannot be achieved without increased production of structural materials, most importantly of steel, it is obvious why iron ore mining and steel production in "developing" countries has steadily increased since 1979. In that year the global output, most of it in "developed" capitalist countries, peaked and began to decline not only as a matter of economics but also because of ecological concerns. Owing to incompetent management of its natural resources, the USSR is now in the position of a "developing" country and has become the source of iron ores for East European countries. At the same time, effective development of the iron mining industry in the USSR will become problematic not only because of weakening CEMA ties but also because of competition from other countries such as Brazil, Sweden, and several African countries. Typically, processing iron oxide ores the the Krivoy Rog Metallurgical Combine can neither technologically nor economically compete with processing of Brazilian crude iron ores or of Swedish and Canadian pellets. In order not to remain in this position but to advance, it is necessary to radically revise the strategy for development of the ferrous metals industry by considering changes in the economic structure here as well as in the European market. The ore mining and processing output will begin to decrease, following restructurization of the economic system with introduction of a new economic mechanism oriented toward lower consumption of materials, especially of metals, and introduction of realistic price schedules for all products of the metallurgical industry. The decline in the supply of pelletized raw iron will result in a much greater demand for high quality, nobody wanting to buy low-grade crude iron ores or concentrates with a high content of silica and other slag makers or pellets with a high content of fines and with poor mechanical characteristics. Emphasis will, therefore, be on the ore dressing and pelletization technology. Only improving the quality of ore pellets will lower the rate of coke consumption in a blast furnace, inasmuch as merely replacing coke with coal dust does not change the actual fuel requirement. So far plans have only been discussed, hardly any progress in ore processing having been made since invention of the belt conveyor in 1911 with hardly any further changes made in the equipment during the last 40 years. The most sensible strategy for action seems to be combining the ore pelletization and reduction processes. This will economize heat, will allow dismantling the coke-chemical industry completely and blast furnaces completely or at least partly, and will lower the level of air pollution. Combining these two processes will also facilitate producing two categories of materials needed for steelmaking: partly metallic iron and completely metallic iron. Another alternative to consider is combining agglomeration and pelletization into a single process of making raw material for blast furnaces, if they are to be retained but made more productive, a major advantage here being that then only the simpler agglomerating equipment will needed without the more complex sintering equipment. Adoption of new technologies by the iron ore processing industry must not be delayed, which in turn will require overcoming the financial road block and rooting out the monopolization of decision making by individual departments. Creation of independent advisory boards made up of top specialists has been proven to be very effective in the largest and most successful firms.

Inventions, Oct 90

917D0118C Moscow METALLURG in Russian No 10, Oct 90 pp 39-40

[Article by V. Kitayskiy, candidate of technical sciences, Department of Metallurgy, All-Union Scientific Research Institute of State Expert Patent Examination]

[Abstract] Seventeen inventions pertaining to metallurgical processes have been examined and certified: 1) A method of cold rolling thin and ultrathin strip with better than before planarity control, with the ratio of lead pull to back tension within the 1.5-4.0 range, is proposed (authors' disclosure No 4,721,156 - 19 Jun 89) by Ya.D. Vasilyev (Bulgaria), S.V. Sizov, O.V. Ivantsov, et al. at the Dnepropetrovsk Institute of Metallurgy. 2) Blowing a hot stream of oxygen together with fuel into the blast furnace through a tuyere with a straight horizontal fuel-jet forming segment, so as to ensure a more nearly complete interaction and to lower the rate of coke consumption, is proposed (authors' disclosure No 4,637,119 - 23 Nov 88) by V.V. Lisitskiy, I.G. Tovarovskiy, Yu.A. Prikhodko, et al. at the Institute of Ferrous Metallurgy. 3) A method of reconstituting the converter lining by covering it with highly basic carbonaceous slag, converter clinker, and firebrick rubble, then alternately soaking this mixture and blowing oxygen through it in 1-min long cycles with the ratio of soaking time to blowing time within (3-5):1, is proposed (authors' disclosure No 4,647,259 - 21 Dec 88) by V.V. Ryabov, O.P. Rastrigin, G.N. Roldugin, et al. at the Novolipetsk Metallurgical Combine. 4) An economical method of making ferromanganese in a rectangular ore-reducing furnace with a row of electrode pairs is proposed (authors' disclosure No 4,660,330 - 3 Jul 89) by V.Ya. Kapelyanov, E.S. Karmanov, G.D. Tkach, et al. at the Dnepropetrovsk Institute of Metallurgy. 5) A case-hardenable high-temperature high-impact die steel (0.26-0.32 % C, 7.72-9.4 % Cr, 1.36-1.8 % Mo, 0.81-1.5 % Si, 0.42-0.75 % V, 0.25-0.5 Mn, 0.04-0.08 % Ce, 0.02-0.8 % Ti, 0,02-0.08 % Zr, 0.02-0.06 % Al, 0.02-0.05 % Ca, 0.003-0.1 % Ba) has been developed (authors' certificate No 4,766,080 - 5 Dec 89) by M.I. Karpenko, Ye.I. Marukovich, S.M. Badyukova, et al. at the Gomel Polytechnic Institute. 6) A charge formulation for making high-carbon ferromanganese (10-18 % carbonaceous reducing agent, 0.2-4.0 % ferriferous additive, 1.0-20.0 % fluxing agent, 2-40 % low-phosphorous clinker pumice of 10-200 mm grain size fraction and 400-1100 kg/m^3 bulk density, remainder manganiferous material), a ferromanganese with a low electrical conductivity and a high gas permeability, has

been devised (authors' disclosure No 4,681,696 - 10 Mar 89) by B.F. Velichko, A.V. Koval, P.F. Mironenko, et al. at the Dnepropetrovsk Institute of Metallurgy. 7) An efficient method of producing hot-rolled tubes, by rolling billets in a Pilger mill, then flame cutting the billets with an oxy-acetylene torch into blanks of gage length, then heating the blanks and rolling them on a long mandrel, is proposed (authors' disclosure No 4,621,316 - 19 Dec 88) is proposed by V.N. Shcherbakova, I.F. Khaydukov, V.A. Sementov, et al. at the Ural Scientific Research Institute of Technology. 8) A method of producing 100 mm and thicker steel strip, by hot rolling to that thickness, then cooling the surface at 10-25°C/s to 500-600°C, then rolling at a 2 m/s or higher speed in 2-4 stages with intermediate cooling, and finally tempering at 650°C, so as ensure a 10-15 % higher strength, a 50 % higher impact strength at -40°C, and a 20-30 % higher thermal stability, is proposed (authors' disclosure No 4,784,484 - 22 Jan 90) by M.Ye. Smagorinskiy and Ye.L. Gyulikhandanov at the Leningrad Polytechnic Institute. 9) A method of producing blinds for color-television kinescopes from low-carbon steel (0.001-0.01 % C) strip at an up to 98.5 % higher than now annual rate, by multistage cold rolling hot-rolled steel strip with intermediate annealing and with final annealing for 1-30 min prior to the final forming operation, is proposed (authors' disclosure No 4,738,450 - 19 Sep 89) by A.D. Deyneko, D.I. Alekseyeva, M.Yu. Bashin, et al. at the Central Scientific Research Institute of Ferrous Metallurgy. 10) An economical and nonpolluting method of producing a hardener for modifying aluminum alloys, by adding to molten aluminum an element which forms with it a eutectic alloy with the same or a lower melting point and then adding fluoroborate + titanium sponge, is proposed (authors' disclosure No 4,764,235 - 1 Dec 89) by T.K. Demykina, M.S. Kolesov, V.P. Kadriychev, et al. at the Siberian Institute of Metallurgy and the Novokuznetsk Aluminum Plant. 11) A method of making high-purity titanium alloy, namely reducing $TiCl_4$ and chlorides of the alloying elements by heating and adding magnesium, then separating the reaction products at 980-1000°C under vacuum, then holding the alloy at 1010-1080°C for 5-35 h, so as to ensure a high degree of phase homogeneity desirable for powder metallurgy, is proposed (authors' disclosure No 4,764,234 - 1 Dec 89) by P.G. Detkov, A.V. Chub, A.F. Shchelkonogov, et al. at the Solikamsk Magnesium Plant, the Berezniki Titanium Plant, and the Berezniki branch of the Titanium Institute. 12) A method of reprocessing manganese ores and slurries for higher-yield manganese extraction, by preparing the charge for sulfate roasting with $(NH_4)_2)SO_4$ + 14.3-20 % $FeSO_4$ x $7H_2$, then leaching the cake with water, and separating the manganiferous concentrate, is proposed (authors' disclosure No 4,747,655 - 12 Oct 89) by V.A. Arsentyev, S.V. Sinenko, O.I. Dzyuba, et al. at the Institute of Mechanical Ferrous Metals Processing. 13) A method of producing aluminum powders with a large yield of small-grain fractions, by atomizing the aluminum melt with a gas stream, cooling the mist with another gas stream (both gas streams being injected into water), so as to prevent aggregation of aluminum particles, is proposed (authors' disclosure No 4,761,167 13 Sep 89) by V.K. Shcherbakov, V.N. Bunkov, V.A. Kondyrev, et al. at the All-Union Scientific Research and Planning Institute of Aluminum, Magnesium, and Electrode Industry, its Irkutsk branch, and the Irkutsk Aluminum Plant. 14) A low-cost method of producing large high-grade ingots by semicontinuous casting into molds so as to ensure concentrated liquefaction in the ingates, with a rotary cooler in the liquid phase moved back-and-forth horizontally while being moved upward at the velocity of and thus ahead of the solidification front, is proposed (authors' disclosure No 4,685,542 - 3 May 89) by G.Ye. Goryaynov, A.I. Chepenko, I.S. Shmukler, et al. at the State Planning Institute of Steel in Kharkov. 15) A charge formulation for making ferronickel (25-30 % limestone, 3-12 % anthracite, 0.1-10 % complex carbide-coal material, remainder nickel ores) by electric smelting of nickel oxides, a charge which will add more Ni and Co to the steel while adding less P and S, has been devised (authors' disclosure No 4,771,166 - 19 Dec 89) by M.I. Gasik, A.G. Grinshpunt, V.V. Kashkul, et al. at the Dnepropetrovsk Institute of Metallurgy. 16) A modifier formulation (25-40 % H_3BO_3, 12-20 % CuO, 12-20 % V-Al alloy, 12-18 % ferrosilicozirconium, 9-12 % Y, 7-13 % silicobarium) for improving the mechanical characteristics and the heat resistance of steel castings has been devised (authors' disclosure No 4,756,186 - 9 Nov 89) by B.K. Svyatkin, M.I. Karpenko, S.M. Badyukova, et al. at the All-Union Polytechnic Correspondence Institute. 17) A modifier formulation (6-15 % Ce-series rare-earth, 5-25 % Si, 5-15 % Fe, 2-7 % Bi, 1-4 % Ca, 0.1-4 % Cu, 0.1-1.5 % Mg, remainder Al) for increasing the resistance of hypoeutectic cast iron to crack growth while decreasing its proneness to shrinkage and microporosity has been devised (authors' disclosure No 4,805,278 - 23 Mar 90) by A.G. Slutskiy, S.N. Lekakh, N.I. Bestuzhev, et al. at the Belorussian Polytechnic Institute.

Inventions, Nov 90

917D0119C Moscow METALLURG in Russian No 11, Nov 90 pp 40-41

[Article by V. Kitayskiy, candidate of technical sciences, Department of Metallurgy, All-Union Scientific Research Institute of State Expert Patent Examination]

[Abstract] Fourteen inventions pertaining to metallurgical processes have been examined and certified: 1) A method of treating the jet of molten metal during transfer from ladle to crucible, by injection of shielding gas from the ladle bottom up in the form of an annular jet around the crucible periphery and down into the entering metal, so as to enhance degassing of the melt and to thus reduce cracking of the ingots, is proposed (authors' disclosure No 4,761,744 - 27 Nov 89) by V.V. Lisitskiy, V.L. Pilyushenko, I.V. Murash, et al. at the Institute of Ferrous Metallurgy and the Cherepovets Metallurgical Combine. 2) A nitriding agent (92-97 % NaOCN, 3-8 % Na_2MoO_4 for nitriding after heat treating worn machine parts and tools made of steel, so as to reconstitute them with a smoother surface and a higher wear resistance, has been developed (authors' disclosure No 4,764,821 - 4 Dec 89) by I.G. Dovgyallo, V.B. Vishnevskiy, S.Ye. Belskiy, et al. at the

Belorussian Institute of Technology. 3) A self-baking anode in the form of an angle bar inside a steel jacket with a thin CaO interlayer, for aluminum production in an electrolyzer with current feed from top down, so that slower oxidation of its lateral surface will lower the rate of anode material consumption and a lower current density with a smaller voltage drop will reduce the consumption of electric energy, has been developed (authors' disclosure No 4,651,934 - 17 Feb 89) by Yu.A. Zverev, V.I. Kravchenko, A.N. Malenkikh, et al. at the Bratsk Aluminum Plant. 4) A method of obtaining a high-purity high-yield cobaltiferous solution from cobalt concentrate containing metallic impurities and the SO_4^- ion, by dissolving the concentrate in HCl, then adding at least 1.5 mol./dm^3 $CaCl_2$, then removing the precipitated $CaSO_4$, then extracting from the filtrate Fe, Zn, and Pb with a 0.14-0.30 mol./dm^3 trialkaliamine hydrochloride solution, Cu with a 0.3-0.7 mol./dm^3 amino salt solution, and Co + at least 8 g-ion/dm^3 Cl^- with a 0.7-1.0 mol./dm ^{3} amino salt solution, is proposed (authors' certificate No 4,727,540 - 22 May 89) by M.L. Naftanovich and L.S. Lutova at the State Planning Institute of Nickel. 5) A method of oxidizing aluminum and aluminum alloys by a nontoxic chemical process which involves only a few operations and an economical use of chemicals, namely surface degreasing with a Sulfanol solution followed by a rinse-etch-rinse-neutralize-rinse cycle and subsequent surface treatment with an aqueous solution of 3-9 g/dm ^{3} Hydroperite (?) + 3-5 g/dm^3 $(NH_4)_2MoO_4$ and $NiSO_4 \times 7H_2O$ pigments at 80-100°C for 10-20 min, followed by rinsing and drying, so as to increase the adhesion strength and thus the corrosion resistance of the oxide film, is proposed (author's disclosure No 4,839,797 - 9 Apr 90) by N.V. Kalganova at the Simferopol Main Special Design and Manufacturing Engineering Office for Pneumatic Apparatus of the Industrial Association "Pnevmatika" (Pneumatics). 6) A method of aluminizing steels with an economical use of chemicals, by electrochemical deposition of coatings from a 29-32 % NaF + 15-18 % NaCl + 44-50 % AlF_3 melt with a current density of 0.05-2.0 A/cm^2 at a temperature within 700- 850°C over a period of 2-10 min, so as to produce more heat-resistant 0.3-0.6 mm thick surface layers on standard steels such as the 40Cr for replacement of high-cost special steels such as the 33Cr3Mo3V grade, is proposed (authors' disclosure No 4,741,097 - 16 Aug 89) by N.V. Temnogorova, I.P. Kharaman, E.N. Simonov, et al. at the Zaporozhye Industrial Institute. 7) An apparatus for water-cooling rolled stock in hot-rolling mills, which includes a distribution chamber, a cooling tower, and a circulation system for recycling dirty water from roughing stands, finishing stands, and roller table, also equipment for thorough cleaning, has been developed (authors' disclosure No 4,793,007 11 Dec 89) by S.Ye. Nikulin, G.S. Pantelyat, S.V. Klimenko, et al. of the Scientific-Industrial Association "Energostal" (Steel for Power Apparatus Construction). 8) An economical method of producing high-grade cast iron, by proper preparation of the charge, controlling the melt temperature, and pouring into molds at a temperature 0.8-1.6 % above the liquidus point of the alloy iron, also storing the raw materials in a stock room with both temperature and humidity control, at a temperature below the dew point but not below 0°C, so as to minimize the number of blow holes, sand holes, and slag pits, is proposed (authors' disclosure No 4,682,890 25 Apr 89) by A.V. Maslov, E.B. Ten, V.B. Belovodskiy, et al. at the Moscow Institute of Steel and Alloys. 9) A high-grade steel (0.3-0.4 % C, 1.05-1.45 % Si, 0.78-1.45 % Mn, 0.18-0.55 Cr, 0.01-0.06 % Ti, 0.01-0.06 % Al, 0.0005-0.005 % B), addition of 0.01-0.06 % Al increasing its ultimate tensile strength by a factor of 1.07-1.31, its percentage elongation by a factor of 1.04-1.45, and its impact strength at room temperature by a factor up to 1.5, has been developed (authors' disclosure No 4,721,815 - 19 Jul 89) by A.A. Azarkevich, T.A. Yevtukhova, N.F. Legeyda, et al. at the Ukrainian Scientific Research Institute of Metals. 10) A method of metallizing sintered porous articles, by electrochemical deposition of a coating of the same metal to fill the pores to a depth equal to 1.1-1.3 times their width under a pressure of 0.02-0.04 N/mm^2, followed by rolling the coated surface, and subsequently heat treating the article at 600-700°C in an inert atmosphere for 1 h, so as to ensure a strong bond and a high heat resistance while retaining the continuity of pores underneath, is proposed (authors' disclosure No 4,682,179 - 21 Apr 89) by V.I. Kober, I.A. Mayburov, and S.P. Raspopin at the Ural Polytechnic Institute. 11) A method of more intensely but not less economically cooling metal sheet while it is conveyed, by cooling a demarcated zone of its top surface with jets of a gas-liquid coolant whose discharge rate decreases uniformly from 20 % above average at the entrance into this zone to 40 % below average at the end of this zone, while its discharge velocity increases by 35-40 % in an inverse-exponential relation to the sheet surface temperature as the latter decreases along this zone, is proposed (authors' disclosure No 4,736,903 - 28 Jun 89) by A.V. Avramenko, V.K. Shvetsov, A.L. Ostapenko, et al. at the Donetsk Scientific Research Institute of Ferrous Metallurgy and the Orsk-Khalil Metallurgical Combine. 12) A method of producing magnetic powders of alloys of rare-earth metals and transition metals, by first dissolving solid stock of the component metals or of their compounds in CCl_4 + 10-90 % $HCON(CH_3)_2$ at a temperature not higher than 150°C and subsequently heating the reactants at their decomposition temperature, is proposed (authors' disclosure No 4,807,940 - 30 Mar 90) by V.P. Seleznev, A.I. Karelin, Ye.A. Filippov, et al. at the Moscow Institute of Chemical Technology. 13) A method of rolling tubes lengthwise, by lubricating the rolls with cakes of solid lubricant while the tube stock is being reduced, pressing the cakes against the rolls in advance and removing them after a delay, both advance time and delay equal to the length of the lubricated arc on the roll surface to its point of contact with the tube metal divided by the peripheral velocity of the roll, is proposed (authors' disclosure No 4,646,911 - 7 Feb 90) by Yu.I. Blinov, Yu.M. Iosifov, V.I. Kuznetsov, et al. at the Ural Institute of Ferrous Metallurgy. 14) A composite microwave absorbing material (50-60 % Ni-Zn ferrite powder, 1-5 % Fe or Co coating on ferrite grains, remainder epoxy resin) whose dielectric permittivity at 9 GHz frequency changes by a factor of 1.4-2.2 without noticeable change of its magnetic permeability has been developed (authors' disclosure No 4,720,642 - 24 Jul 89)

by V.N. Berzhanskiy, V.I. Ponomarenko, Ye.D. Pershina, et al. at the Simferopol State University.

Improved Design of Vacuumizing Steel Degasser

917D0118B Moscow METALLURG in Russian No 10, Oct 90 pp 35-36

[Article by A.B. Antipova, A.D. Sborshchik, A.A. Krivosheyko, G.A. Voronov, V.L. Kostenko, and V.V. Zagoyko, Magnitogorsk Metallurgical Combine, All-Union Planning Institute of Steelmaking, and "Magnezit" Combine]

[Abstract] The vacuumizing steel batch degasser operating at the Magnitogorsk Metallurgical Combine since 1972 and processing 250,000- 300,000 tons of metal annually has been redesigned for higher productivity and better product quality. The diameter and the height of the suction nozzle are increased from 1020 to 1290 mm and from 1380 to 1500 mm respectively. A welded permanent connection to the vacuum chamber replaces the bolted flange coupling, a 250 mm thick inside lining replaces the 125 mm thick one and a 200 mm thick outside lining replaces the 100 mm thick one. The inside lining is made of fused periclase-chromite refractories, a mixture of two rather than five size fractions, and the outside one is made of cast corundum. A jacket of stainless steel metal the nozzle prevents its oxidation and makes it useful for 600-900 batches of molten metal instead of only 120-140. After every such run the jacket is cut off and a new one is welded on, its 300-400 mm long skirt being replaced during each run. A cap of sheet metal is welded onto the bearing plate of the nozzle at the end of maintenance shutdown, to cover the inlet hole in it and thus hermetically close the vacuum chamber as the latter is reheated to the operating temperature. This cap is then burned away with oxygen prior to the first immersion of the nozzle in the molten metal, so that molten metal can again flow into the vacuum chamber. With this new suction nozzle, the degasser will process 146-283 batches of molten metal between maintenance shutdowns and thus 511,000 tons annually. Figures 2.

Outlook for Use of Metals and Nonconventional Materials

917D0119A Moscow METALLURG in Russian No 11, Nov 90 pp 32-34

[Article by D.I. Ryzhonkov]

[Abstract] The outlook for production of metals and nonconventional metallized materials is examined by concurrently projecting the demand for various materials and the depletion of natural resources, in the USSR and in the U.S. to the year 2000. As the Gross National Product in both countries is assumed to be increasing, the production of various materials is expected to increase at various rates: an even faster decreasing rate (copper, carbon steels), at an about equally decreasing rate (aluminum), at a steady rate (special alloys, high-grade alloys, stainless steel, consumer plastics), at an increasing rate (advance polymer composites, glass-fiber optics, engineering plastics, high-grade structural plastics, conventional structural plastics), while intense research and development are underway in structured ceramics and cermets. Progress is expected to be made in materials with special biological as well as chemical and physical properties for applications such as artificial human organs, in materials with high mechanical strength and heat resistance, ceramics and low-molecular polymers with specific electrical conductivity characteristics to replace much less corrosion-resistant metals. At the same time, the demand for materials can be lowered by designing products for longer life and by minimizing the use of scarce materials, and particularly increasingly scarce materials in the design of products. A useful tool for planning and predicting the demand for and the production of materials is a vector representation of the trend in the "degree of product complexity - mass of material per product sample" plane. A typical industry heavily involved in materials science and development is the aero-space industry, where the weight fractions of irreplaceable steel per aircraft, of steel replaceable by titanium, and of titanium replaceable by aluminum will not change, but that of aluminum will decrease and that of composite materials will increase. Planning the conservation of materials will necessarily have to include more nearly complete extraction of metals from their ores and their recycling from scrapped products. Figures 5.

New Scheme for Production of Rails Hardened by Heat Treatment

917D0119B Moscow METALLURG in Russian No 11, Nov 90 pp 36-38

[Article by D.K. Nesterov, V.N. Yermolayev, V.A. Stepanov, A.G. Menshikov, N.F. Levchenko, and Ye.L. Belkin, Ukrainian Scientific Research Institute of Metallurgy and USSR Ministry of Metallurgical Industry]

[Abstract] A scheme for producing rails hardened by heat treatment is proposed which includes furnace heating and is applicable to long rails from 50 m up, furnace heating being the only method of heat treating with the promise of high productivity and long rails being preferred on account of not only fewer joints subject to heavy dynamic loads but also lower maintenance costs. Treatment of a hot-rolled rail strip according to this scheme consists of: 1) cooling to 500-600°C for completing structural transformations over the entire cross-section; 2) heating its head in an induction or gas-flame furnace to the appropriate temperature for subsequent quenching with a water-air spray, then self-tempering during continuous-sequential conveyance; 3) cooling on a cooler rack; 4) straightening with a roller leveler by stretching the entire rail strip; 5) cutting into segments of gage length, followed by finishing operations such as drilling and countersinking bolt holes. Some heat from the rolling operation can be utilized for this heat treatment. For estimating the temperature, stress, and strain distributions over the rail cross-section, the heat treatment process was simulated mathematically on a Standard System 1033 computer with the thermophysical properties of rail steel and their nonlinearity as well as the volume changes attending its structural transformations

taken into account. The deflection of a rail, maximum (49-55 mm radius of curvature) at the pre-quenching temperature and at the cooldown temperature, was found to depend not only on technological parameters but also on the weight of a rail at the end of the heat treatment process and on the stiffness of the quenching stands. The scheme was tested on 800 mm long R-50 rail samples in a laboratory experiment at the Ukrainian Scientific Research Institute of Metallurgy. Quenching produced an 18-20 mm deep case. A rail emerging from the cooling zone had a convex head. Without aftercooling on the rack, the rail became concave with a 107 mm radius of curvature as it had cooled down naturally to room temperature. Aftercooling on the rack to room temperature prevented this reversal of curvature so that the rail head remained convex with an approximately 50 mm radius of curvature. The experimental data agree with theoretical estimates, which confirms the feasibility of controlling the curvature of rails by aftercooling. Further projections indicate, moreover, the feasibility of producing durable 50-100 m long straight rails with geometrical characteristics which meet the toughest world standards.

Cord Materials: Backup for Effective Spray Coating

917D0121D Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian No 5, Oct 90 pp 89-93

[Article by Zh.Zh. Zhenbayev and M.A. Samsonov, Institute of Physics, KiSSR Academy of Sciences, Frunze]

UDC 621.793.7

[Abstract] Considering that many refractive metals as wells as all oxides, carbides, and nitrides used as wear-resistant coating materials cannot be formed into wire deposition by plasma spraying, it has been proposed to form the powder of such a material with an organic binder into flexible cord. Coating with a material in this form requires a special technology, namely center feed of the cord into the heating zone for atomization by several plasma jets merging symmetrically around it. The binder either burns out or sublimates in the process while the coating material, either as a melt or still as a powder, becomes suitable for deposition. The plasmatron with two jets has built at the Institute of Physics (KiSSR Academy of Sciences) was used in an experimental feasibility study with cords of nonfriable disperse materials, polydisperse materials, and fine-disperse materials. Cords were produced by extrusion using cellulose, polyethylene, an ester, or other organic substance as binder. In the experiment with nonfriable disperse materials, cords 3.6 mm in diameter were produced from slurry of R-6Mo5Co5 high-speed tool steel powder with 4 wt.% binder and atomized by two jets of argon+air plasma (27 kW) converging at a 60° angle. The thus deposited coatings were found to have a high resistance to wear, including abrasive wear. In the experiment with polydisperse materials, coatings of PG(Ni-Cr)Si-B-2 self-fluxing alloys were deposited directly from powder, by fusion of the powder after deposition, and from cords made of 20-160 μm powder fractions. Coatings deposited from cords by two plasma jets (22 kW) did not require fusion, a desirable feature for coating articles which do not tolerate intensive heating. Air plasma was used for deposition of coatings from cords of PG(Ni-Cr)SiB 2-01 powder with 2-8 wt.% binder. Argon plasma was used for deposition of coatings from cords of PG(Ni-Cr)Si-B 2-03 powder without binder. In this experiment coatings were also deposited from cords of $60Cr_3C_2$ + $40Ni_3N_29$, 60WC + $40Ni_3N_29$, 15TiC + $85Ni_3N_29$ powders with 2-8 % binder, and for reference also from Sv-08 welding wire. The study has confirmed the advantages of coating from cords made of powder material, namely: uniform feed and nearly full utilization of coating material, firm tightness of coating, low cost of process, and less oxidation of metal by air plasma owing to oxidation of organic binder. Figures 3; tables 2; references 9.

Structure of Gas Stream in Plasmatron Channel with Permeable Walls and Porous Injection

917D0121C Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian No 5, Oct 90 pp 83-88

[Article by I.A. Bezrukov, R.Ya. Zakharkin, and Yu.R. Shirokov, Podolian Scientific Research Institute of Technology]

UDC 537.523.5:562.766

[Abstract] The structure of a gas stream injected into the arc channel of a plasmatron is analyzed, a channel 9.0 cm long and 5.0 cm in diameter consisting of two (or more) interelectrode insert segments with permeable walls between the anode and a diaphragm in front of the cathode. Gas is injected into the interelectrode gap tangentially through eight orifices 2 mm in diameter from the cathode at a rate G_1, through two orifices 2 mm in diameter from the diaphragm at a rate G_2, normally through the two permeable insert walls at rates G_3 and G_5, tangentially through six orifices 2.8 mm in diameter between the inserts at a rate G_4, and tangentially through six orifices 2.8 mm in diameter from the anode. First is considered confluent injection through all orifices G_1 (from cathode) +G_2 (from diaphragm) + G_4 (from between inserts) + G_6 (from anode). Then is considered counterfluent tangential injection G_1 (from cathode) + G_2) (from diaphragm) and G_6 (from anode) + G_4 (from between inserts). The complete radial profiles of tangential velocity and static pressure along the channel in both cases, also radial profiles of axial velocity in the case of counterfluent injection, have been calculated for various combinations of nitrogen injection rates. The results indicate that the in a channel with confluent tangential injection the path of reverse flow closes up at much smaller ratios of tangential to porous (normal) injection rates in a long channel with two inserts than in a short channel with only one, further increase of porous injection shifting the closure toward the

cathode. Lengthening the arc channel by addition of more inserts does not destabilize it within the paraxial region, tangential twist of an injected gas stream evidently stabilizing it by shaping the radial profile of static pressure into a parabolic one throughout the length of the channel. Counterfluent tangential injection shifts the much of the gas mass from the channel periphery toward the axis, which facilitates intensification of the arc-to-gas heat transfer and thus boosts the voltage. This has been confirmed by a "hot" experiment. It ceases to be effective when the tangential injection rate is equal or close to the rate of direct injection, inasmuch as gradient of static pressure within the paraxial region will become zero and the arc may be diverted to the channel wall.

UDC 621.793:620.1

Porosity of Plasma-Sprayed Composite Coatings

917D0121A Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian No 5, Oct 90 pp 57-72

[Article by V.V. Kudinov, P.Yu. Pekshev, A.F. Chistyy, and Ye.I. Yakovleva, Institute of Metallurgy imeni A.A. Baykov, USSR Academy of Sciences, Moscow]

[Abstract] Experimental studies were made concerning the structural characteristics of two porous composite coating materials produced from powders by plasma spraying: ZrO_2 x Y_2O_3+ NiCr and W+ Cu. The ingredients were $Zr0_2$+ 4.26 wt.% Y_2 O_3 powder, 80Ni-20Cr nichrome powder, grade W-5 tungsten powder, grade MA copper powder. Spraying was done in an open atmosphere under normal pressure in the "Plasma-Technik" (Swiss) apparatus with an F4-MB plasmatron using Ar+ H_2 mixtures as the plasma generating gas. Porosity was measured by the mercury method with an "Autopor 9200" (Micrometrix, USA) instrument and by microstructural examination including fractography. Thus have been determined both porosity and density of the composite coatings as well as of their ingredients, depending on the weight fractions of the latter (0-100 %) and on the spraying distance (80-170 mm). A further evaluation of the data has yielded two other important structural characteristics, namely the average diameter and the specific surface of pores, depending on the same process parameters. Differential porograms, diameter distribution (0.01-1000 μm) of specific volume (m^3 per kg of material) have been plotted on the basis of these data. Figures 14; tables 3; references 20.

Properties of Coatings Plasma-Sprayed From Ni-Cr-Si-B Alloy Powders

917D0121F Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian No 5, Oct 90 pp 103-108

[Article by V.G. Demidov, Institute of Coal, Siberian Department, USSR Academy of Sciences, Kemerovo]

UDC 539.211/539.53+621.793.8

[Abstract] An experimental study of coatings plasma-sprayed from PG(Ni-Cr)Si-B 3,4 self-fluxing alloy powders was made, with the composition of these powders varied from hundredths of a percent C to several percent B, Si, Fe, and to 20 % Cr. Steels of standard series were coated in a PP-25 plasmatron, its current being varied over the 300-450 A range at voltages of 35-40 V. As the plasma generating gas, Ar + up to 10 % N_2 was used. After deposition the coatings were fused by heat treatment with an oxypropane torch or in an electric furnace at 1050°C, phase transformations and structural changes having occurred in the process. The microstructure of the coatings was then examined and their porosity determined in an "Epiquant" analyzer with x1000 magnification. Phase analysis was performed in a DRON-3M x-ray diffractometer with a CuK_α-radiation source and a β-radiation filter. Adhesion strength was measured with an ALA-TOO apparatus and a 2054 R-5 press. Hardness and microhardness were measured with a 2140 TR Rockwell tester and a 2137 TU Vickers tester respectively, the latter with 49 N, 98 N, and 153 N indenters giving more accurate readings. Evaluation of the x-ray diffraction data according to the Bragg-Wulff law and using constitution diagrams for the Ni-Cr-Si-B system revealed α-phase Ni-Cr, Ni-Si, Ni-B solid solutions, tetragonal and hexagonal Ni_2B, Ni_5Si_2, Cr_5Si_2 phases, possibly also B_4C and BN phases. Porosity was measured volumetrically by the metallographic method, which yielded a pore size distribution mathematically describable as a gamma distribution $\Pi(X) = N\beta^{\alpha}X^{\alpha-1}e^{-\beta}/\ \Gamma(\alpha)$ (X- mean diameter of pores within a size fraction, N- normalizing factor) with different values of N,α,β before and after fusion. The adhesion strength was anomalously high, becoming on the average by 140.7 N/mm^2 higher after fusion and thus comparable with the strength limits of structural steels. Hardness measurements revealed a stratification of the coatings into an independent upper coating layer 1.0-1.5 mm above the base metal depending on the load, a transition layer including a 200-400 μm thick diffusion sublayer, and a homogeneous layer of base metal underneath. The hardness of the transition layer decreased as its thickness decreased under load, the hardness readings here therefore being unstable. Figures 4; tables 1; references 11.

Interphase Heat Exchange During Radial-Annular Injection of Disperse Material Into Plasma Stream

917D0121B Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian No 5, Oct 90 pp 73-82

[Article by O.P. Solonenko and A.L. Sorokin, Institute of Thermophysics, Siberian Department, USSR Academy of Sciences, Novosibirsk]

UDC 621.793:533.9

[Abstract] Treatment of disperse materials in plasma jets is considered, radial-annular injection of powder into the

plasma jet being proposed as an improvement over known conventional methods. Its advantages are higher productivity and efficiency, owing to formation of a radially converging axisymmetric powder jet directly behind the anodic arc spot and thus avoidance of powder precipitation on cold plasmatron walls. Another advantage is the possibility of using interchangeable accessories such as diffusers with hot walls. A physical model of this process is constructed for an engineering design and performance analysis, the main two concerns being the dynamics of powder flow through the initial plasmatron channel segment and the attendant interphase heat transfer from the axial stream of hot gas to that powder. Inasmuch as the powder particles do not have sufficient time to spread over the channel cross-section and the flow of powder is thus highly localized, the portion of the channel cross-section they occupy will be determined by turbulent diffusion as well as by their initial diameter and velocity. For an approximate analysis, the plasma stream is treated as turbulent stream of a hot homogeneous gas not influenced by powder particles. The trajectory of a solitary powder particle in it is calculated accordingly, whereupon the effect of turbulent diffusion (random process) on its trajectory is estimated on a statistical basis. Next are considered the spread of initial particle diameters and the resulting spread of dynamic relaxation time. The problem of powder flow dynamics is then coupled to the problem of thermodynamics, this being a multiparametric problem owing to the temperature dependence of thermophysical properties. Calculations are somewhat simplified by averaging the specific heat of both powder material and plasma gas over a given temperature range. The heating of a powder particle is described by the two-dimensional differential equation for the rate of its temperature rise as the sum of its axial velocity times the axial temperature gradient and its radial velocity component times the radial temperature gradient, equal to the difference between gas temperature and powder temperature divided by the thermal relaxation time. This equation, in the approximation of a constant thermal relaxation time $\tau_T = c\rho D^2/(6\kappa N_{Nu}$ (c,ρ- specific heat and density of powder material, D- diameter of powder particle, κ- thermal conductivity of gas at its temperature, Nu- Nusselt number), is converted into a partial differential one for the enthalpy of a jet of powder particles. This equation is then solved for the total enthalpy of the powder. On the basis of this complete model and specific numerical process data pertaining to alumina powder and air plasma, radial-annular injection into an axial gas stream is compared with conventinal unilateral transverse injection into the anode nozzle and shown to have much better performance indicators. Tables 1; references 10.

Thermal Processes and Structural Changes During Laser-Beam Alloying of Steel Surface

917D0121D Novosibirsk IZVESTIYA SIBIRSKOGO OTDELENIYA AKADEMII NAUK SSSR: SERIYA TEKHNICHESKIKH NAUK in Russian No 5, Oct 90 pp 94-98

[Article by V.P. Larionov, N.P. Bolotina, F.G. Vinokurov, and T.V. Argunova, Institute of Problems in Engineering Physics, Siberian Department, USSR Academy of Sciences, Yakutsk branch]

UDC 621.793:539.184.28

[Abstract] Alloying a steel surface by laser-beam is analyzed for the effect of attendant thermal processes on both structure and chemical composition of the surface layer. Theoretical calculations are based on the model of transient heating and cooling during treatment by a heat source which moves in one direction at a constant velocity V and forms a spot with a Gaussian intensity distribution. Solution of the corresponding equation of heat conduction for a metal occupying the $z < 0$ half-space and a laser spot moving along the 0X axis yields the temperature field T(x,y,z,t) integral. The absorption coefficient as well as thermal conductivity and thermal diffusivity of the metal have been assumed to be constant. Thermal effects of phase transitions and heat dissipation from the metal surface have been assumed to be negligible. The laser spot radius $r = [(x- V)^2+ y^2]^{1/2}$ (in a cylindrical system of coordinates moving with the laser beam) and the heat penetration depth z are treated as small parameters for calculation of the temperature changes ΔT relative to the initial temperature T_0, assuming the characteristic time of thermal processes in the affected metal layer to be of the order of 0.01 s and the velocity of the laser spot on the surface to be much lower than the laser beam diameter divided by that characteristic time. Expressions for the melting depth and the threshold laser power to reach the melting point T_m melting point are obtained after return to the stationary rectangular system of coordinates, whereupon an equation of kinetics is obtained for both heating and cooling rates $\delta T/\tau$. On this basis have been plotted isotherms and lines of equal cooling rates in a cylindrical slug of metal twice as wide (radius 2 mm) from the center of the laser spot and twice as deep (2 mm) from the surface as the T_m isotherm. Structural changes are analyzed on the basis of experimental data, a 0.3-0.4 mm thick coating from Ni-Cr-Si-B powder having been deposited on low-carbon steel by plasma spraying with a CO_2-laser with stepwise 1.9- 1.5-1.2 kW power regulation. Steel specimens were moved under the normally incident laser beam at a velocity of 2 cm/s and the laser spot, 1.0 mm in diameter, was thus made to scan the surface at this rate. Microstructural examination revealed a nonuniform structurization after melting, a fine-grain layer over a granular structure in the crater underneath with small dendrites with undeveloped second-order axes fanning out in the direction of heat flow. The chemical and phase composition of the surface layer, depending on the treatment conditions, was found to be determined by flow of molten material under pressure of its vapor and attendant mixing during intense evaporation rather than by diffusion and thermocapillary mixing. On this basis has been determined the Ni, Cr, and Si distribution (wt.%) across the thickness of the alloyed surface layer as well its actual thickness, all changing appreciably with decreasing laser power. Figures 2; tables 1; references 6.

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